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LOWER FLATHEAD RIVER FISHERIES STUDY

Annual Report 1983

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LOWER FLATHEAD RIVER FISHERIES STUDY

ANNUAL REPORT 1983

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Sponsored by
Bonneville Power Administration
Portland, Oregon
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ABSTRACT

In January of 1983 a two-phase study of the lower Flathead River was initiated by the Confederated Salish and Kootenai Tribes with funding provided by the Bonneville Power Administration. The study fulfills program measure 804 (a) (3) of the Columbia River Basin Fish and Wildlife Program. During 1983 Phase I of the study was completed resulting in a detailed study plan for the next four years and the methods to be employed during the study. Preliminary observations suggest the present operation of Kerr hydroelectric facility and land use practices within the drainage have combined to significantly reduce spawning success of salmonids and northern pike, and thus recruitment to the fisheries of the main river and tributaries. Main river spawning marshes were observed to be drained frequently during the northern pike spawning season which would result in desiccation of eggs and loss of attached fry. Water level fluctuations also caused trapping of juvenile fish and may be an important source of juvenile mortality.

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INTRODUCTION

The lower Flathead River, from Flathead Lake to its confluence with the Clark Fork River, represents a major natural resource for the Indian people of the Flathead Reservation, today as well as historically. Equally important are the tributaries which feed the lower Flathead River. Subsistence hunting and fishing have been, and continue to be, culturally and economically important to the Salish and Kootenai people. Additionally, the benefits derived from hydroelectric power production, sports hunting, and fishing by non-Indians are recognized by the Tribes. Sound management of the fish and wildlife resources of the lower Flathead River system, in conjunction with hydroelectric power production, is of vital interest to the Tribes.

The following description of Kerr hydroelectric facility **and** operation is taken from "Montana Recommendations for Fish and Wildlife Program" (Graham et al. 1981):

Kerr Project Description

"Kerr Dam is a 200 foot high concrete arch structure across Flathead River and is located 4.5 miles downstream from the outlet of Flathead Lake. The dam is located on Confederated Salish and Kootenai Tribal lands. Kerr Dam, constructed primarily for hydropcwer, was closed in April of 1938. The license was amended and transferred from Rocky Mountain Power Company to the Montana Power Company in August 1938. Three generation units were installed; one in 1939, one in 1949 and the last in 1954. Each unit has a 56,000 kilowatt generating capacity for a total of 168,000 kilowatts. The Kerr project is currently operating under extension of a license which expired May 22, 1980. Montana Power Company and the Salish-Kootenai Tribes have filed for relicensing (Federal Energy Regulatory Commission 1980).

"Kerr Dam controls the water level of Flathead Lake between elevations 2883 and 2893 feet. This represents a storage capacity of 1,217,000 acre-feet. In most years, spring runoff produces a volume of water which not only refills the storage area, but also causes a continuous discharge over the dam for a month or more. The hydraulic capacity of the three generators is 14,346 cfs while the mean river discharge is 11,730 cfs. Lake elevations are also altered by Hungry Horse Dam upstream from the lake on the South Fork of the Flathead River. Hungry Horse Dam was closed in 1951 (Federal Energy Regulatory Commission 1980).

Project Operations

"Operation of Kerr hydroelectric development is coordinated with that of other hydro resources of the Northwest Power Pool. Draft on storage usually begins in mid-September and reaches a maximum drawdown at the end of March or mid-April. In this period, use of storage releases from Hungry Horser Reservoir, together with those from Flathead Lake, makes generation possible at a plant factor of 75 to 80 percent. During remaining months of the year, generation depends on the volume of runoff available in excess of that required to refill reservoirs. In many years, the plant continues to operate at a high point factor through May and June (Federal Energy Regulatory Commission 1980).

"Because of the natural channel restrictions between Flathead Lake and Kerr Dam, the maximum rate of discharge through the outlet channel when Flathead Lake is at elevation 2893 feet is 55,500 cfs. The historic rate of inflow has been as high as 176,000 cfs on June 9, 1964.

"Because inflow, during periods of high runoff, can greatly exceed maximum outflow, drawdown on storage begins in mid-September to allow for flood control during spring. The maximum rate of outflow at drawdown (elevation 2883 feet) is 5,200 cfs because of natural channel restrictions in the lake outlet. If the plant relays off when not spilling, no flows will be released through turbines for a short time.

“Montana Power company relies on Kerr project for the bulk of its system’s load frequency control. This often requires changing flows through Kerr very rapidly. This power peaking operating regime may involve going from full to minimum load or vice versa in an emergency situation. Other strategies to optimize power output from Kerr include filling the reservoir each summer and achieving maximum draft of the lake prior to spring runoff. Operational planning is based on a minimum daily average release of 1500 cfs (correspondence dated 9 September 1981 presented by the Montana Power Company at the MDFWP ad Hoc Committee meeting, Missoula, Montana), which is considerably below the USFWS proposed minimum instream flow of 3200 cfs (letter to the Federal Energy Regulatory Commission dated 10 March 1982 from John G. Woods, U.S. Fish and Wildlife Service).

"Kerr Dam is included in the Pacific Northwest Coordination Agreement. Stipulations in the agreement (Montana Power Company 1981) include:

1. Maintain Flathead Lake elevation in accordance with the energy content curve determined under the agreement. This agreement provides for operation of all major facilities on the Columbia River. The use of the energy content curve provides for maximizing the amount of hydroelectric energy production under most prudent constraints.
2. Operate below the energy content curve only if all reservoirs are at cr below their energy content curve.

3. Release stored water above their energy content curve at the request of downstream users or provide “in-lieu" energy to replace the energy the water would have provided if it had been released.

4. Comply with numerous other conditions of the agreement.

“On May 31, 1962, the Montana Power Company and the Corps of Engineers negotiated a “Memorandum of Understanding" which set further principles and procedures for regulation of Flathead Lake in the interests of flood control. This agreement provides that, conditions permitting, the lake will be drawn down to elevation 2,883 feet, the minimum water level under the license, by April 15 and raised to a maximum level under license, by June 15. When the lake reaches elevation 2,886 feet in a moderate or major flood year, the licensee will gradually open spill gates and not close them until after the danger of exceeding elevation 2,893 feet has passed. This agreement has been endorsed by a group of local landowners and recreationists (Federal Energy Regulatory Commission 1980).

“The Montana Power Company currently has no definite plans for further development of the project and proposes to continue past operations. However, several options to increase energy output have been surveyed by government agencies and Montana Power Company. Options include: raising the dam and elevation of the reservoir, enlarging the lake outlet to increase maximum flow rate (at lake elevation 2,883) from 5,200 to 30,000 cfs, rewinding the present generators, and installing an additional-generator (Federal Energy Regulatory Commission 1980)."

Study Objectives

Fisheries data, aside from a general inventory in 1979 by the United States Fish and Wildlife Service and annual spot checks by the United States Fish and Wildlife Service, are largely lacking on the lower Flathead River system (Peterson 1977, 1978; Randall 1980). This situation makes sound fisheries management of the lower river system and identification of hydroelectric impacts difficult. Mountain whitefish (*Prosopium williamsoni*) and five species of trout, rainbow (*Salmo gairdneri*), cutthroat (*Salmo clarki*), brown (*Salmo* trutta), brook (*Salvelinus fontinalis*), and bull (*Salvelinus confluentus*) exist in the lower river and its tributaries, but the impact of water level fluctuation (due to hydroelectric facility operations) on their present status and role in the ecosystem is unknown. Similarly the impacts of the diversions, instream flows, and main river fluctuations on tributary stocks are also unknown. There is also a significant data gap on the relationship that tributary stocks play in maintaining main river populations of trout.

Northern pike (*Esox lucius*) and largemouth bass (*Micropterus salmoides*) are non-native species which have become established in the lower Flathead River, especially below the mouth of the Little Bitterroot River. Fishing pressure on these two species in the lower river has been light, but is expected to increase dramatically as their availability becomes generally known. Both of these important game species spawn in relatively shallow water, and their spawn is highly vulnerable to river level changes caused by hydroelectric operations. The location and extent of spawning areas for these two species is presently unknown and will be delineated during the study. Pike originally entered the lower Flathead system via the Little Eitterroot, and are known to spawn throughout the lower portion of the Little Bitterroot, but in what numbers or how successfully is unknown.

Funded by the Bonneville Power Administration, the Lower Flathead River Study will fulfill program measure 804 (a) (3) of the Columbia River Basin Fish and Wildlife Program and consists of two phases. Phase One has been conducted during FY 83 and has developed the needed biological and technical methodologies and habitat inventory that will best provide the required data to complete our objective of developing management alternatives. The selection of permanent study sections and weir sites has been accomplished during Phase One. Development of techniques to sample specific habitat types has been completed. The number of study sites needed to provide statistically accurate and precise information in any specific habitat type has been based upon developed sampling techniques and observed natural variation. The product of Phase One is a detailed study plan covering sampling, scheduling, and funding estimates and man-power needs for Phase Two.

Phase Two of the study will be conducted in FY 84 - FY 87 and will focus on extensive sampling of habitat and target fish populations, and how these are affected by hydroelectric operations. Phase Two will, in most cases, allow us to follow a year-class of fish from spawned egg to reproductive adult and will reveal a more complete picture of which habitat components, man-made or natural, may be acting as limiting factors. Additionally, the four-year time span should permit recognition of natural variation in target species populations resulting from differential year class success. It is anticipated that the last half of FY 87 will be used to complete the final study report, during which management alternatives will be finalized and mitigation measures suggested.

This study will provide a technical data base for the fisheries resources of the lower Flathead River and its tributaries from which an array of management/mitigation alternatives can be developed covering the present status of hydroelectric development and operation and possible further development. It will be used by Tribal decision makers and other interested parties in making informed management decisions for the necessary level of protection, enhancement, or mitigation of the fisheries resource.

The study began in December, 1982, with the following objectives:

I. Assess existing aquatic habitat in the lower Flathead River and its tributaries and its relationship to the present size, distribution, and maintenance of all salmonids, northern pike, and largemouth bass populations.

II. Assess how and to what extent hydroelectric develcp-ment and operation affect the quality and quantity of aquatic habitat in the lower Flathead River and its tributaries and life stages of existing trout, pike, and largemouth bass populations. Evaluate the potential for increasing quality habitat, and thus game fish production, through mitigation.

III. Develop an array of fisheries management options to mitigate the impacts of present hydroelectric operations, demonstrating under each management option how fish populations and hydroelectric generation capabilities would be modified. Additionally, possible further hydroelectric development and operation and its impacts on target species would be considered.

MAIN RIVER

DESCRIPTION OF STUDY AREA

The lower Flathead River is one of Montana's largest rivers, with an annual average discharge of 340 m^3/second. Today the lower river begins at Kerr Dam, located 7 kilometers (km) southwest of Polson, Montana. Flowing south and west for 116 km, the river flows into the Clark Fork River near Paradise, Montana (Figure 1). Approximately 110 km of the river are within the boundaries of the Flathead Indian Reservation, the second largest Indian Reservation within the State of Montana.

During the last of the ice advances approximately 25,000 years ago, a continuous ice sheet covered the Rocky Mountain Trench to the site of Flathead Lake. The Cordilleran Ice Sheet extended as far south as present day Buffalo Rapids, 7 km below the Kerr facility. For more than 10,000 years the remaining 109 km of the lower Flathead lay quietly under the waters of Glacial Lake Missoula. Approximately 12,000 years ago, Glacial Lake Missoula began to drain,and once again the lower Flathead River began to form its channel.

The first 7 km of the lower Flathead cuts through a glacial morain forming a steep rocky canyon characterized by extensive white-water areas.

The lower river cuts through highly erosive lacustrine and alluvian sediments deposited during the

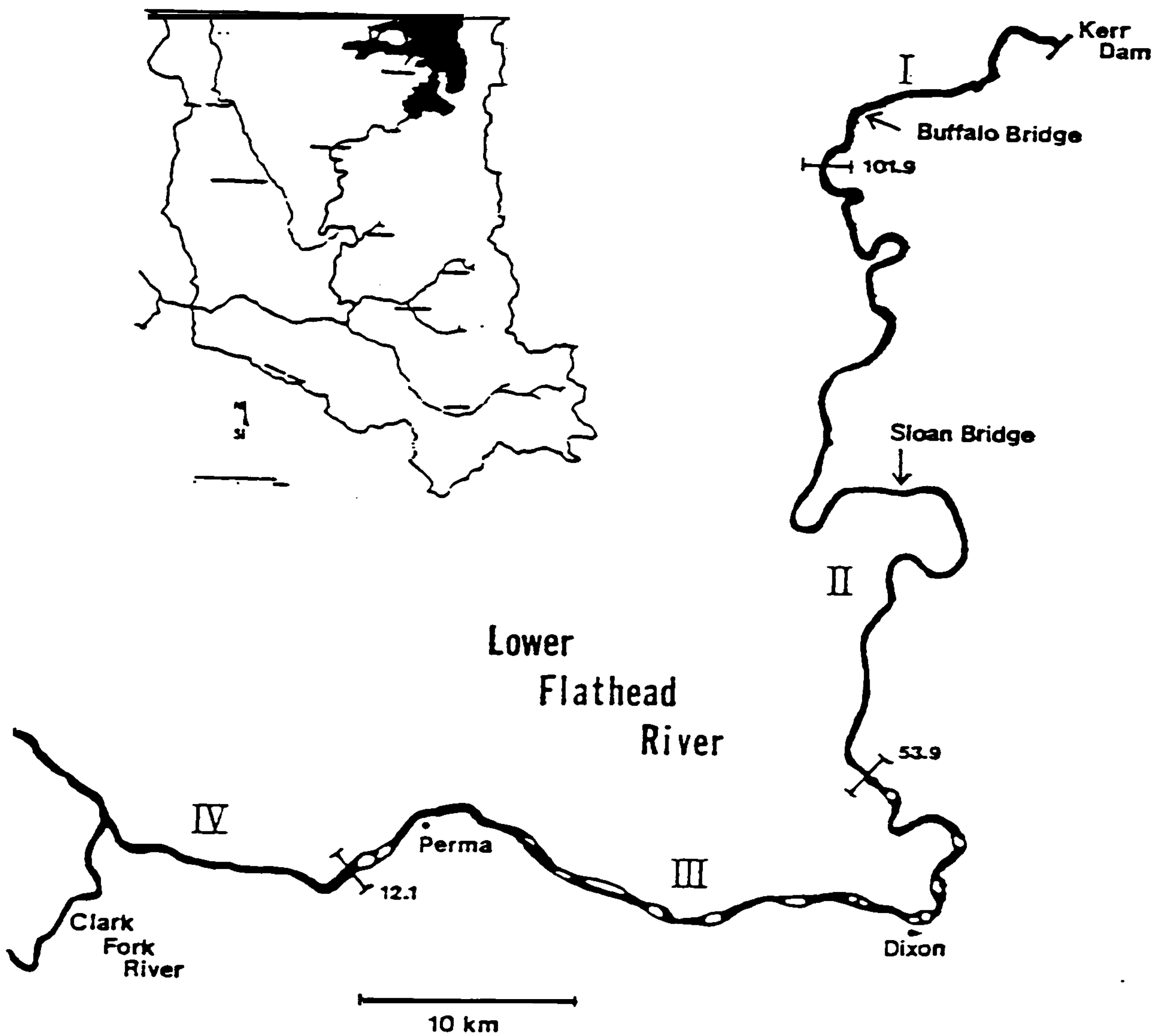


Figure 1. React: breaks of the Lower Flathead River.

life span of the glacial lake. These sediments have a high concentration of clay, sand, and silt, with gravels comprising a small percentage (Montague et al. 1982). Bedrock formations are found in a few areas along the river. Irrigated croplands border the eastern and southern banks of the river; to the west and north is open rangeland.

The Lower Flathead River drains 386,205 hectares, and is basically a low gradient river. Riffle and pool areas blend forming a comparatively smooth flowing river. Average annual rainfall ranges from 40 to 50 centimeters (cm).

Polson Bay, outlet for the river from Flathead Lake, has approximately 6,475 surface hectares and averages 4.9 meters (m) in depth. During the summer, lower river water temperatures are slightly higher than those recorded in thw upper river above Flathead Lake due to the natural warming of Polson Bay. Maximum water temperature in 1981, recorded directly below Kerr Dam on the lower river, was 23.5°C; at Columbia Falls on the upper river, the maximum water temperature recorded was 20.0°C (Shields et al. 1982). Lower water temperatures are higher than those of its tributaries. Water temperature recorded in early August at the mouth of the Jocko River was il C; water temperature in the main river, directly above the mouth of the Jocko was 22°C. During 1982, summer water temperatures in the main river were within the 20.0° C range, and winter temperatures reach 0.0° C. Average annual water temperature was 9.0 °C (Shields et al. 1983).

Kerr facility is power peaking plant. The annual hydrograph for releases from the facility is similar to the pre-impoundment hydrograph with a reduction in peak flows and an increase in winter flows (Figure 2).

Based on general valley characteristics, gradient, and channel morphology, the lower Flathead can be divided into four distinct river reaches (Figures 1 and 3). Reach I of the lower Flathead extends from Kerr Dam (River Kilometer (RK) 116) to the mouth of White Earth Creek (RK 102). Gradient is 1.5 m/km, and the river has an average width of 114 m. The river is confined in a steep rocky canyon for the first 6 km of this reach, after which the canyon widens. The channel bottom is composed of a large boulder-bedrock mixture blending into a cobble-gravel mixture toward the end of the reach. The canyon portion of this reach is primarily a whitewater area characterized by deep pools an-d several sets of rapids. The lower section of the reach is a smooth, fast flowing glide with two riffle areas. This river reach is subject to severe water level fluctuations due to hydropower peaking operations at Kerr Dam. At the U.S. Geological Survey gaging station downstream from Kerr Dam, water levels have fluctuated from 0.6 to 2.4 m in three hours.

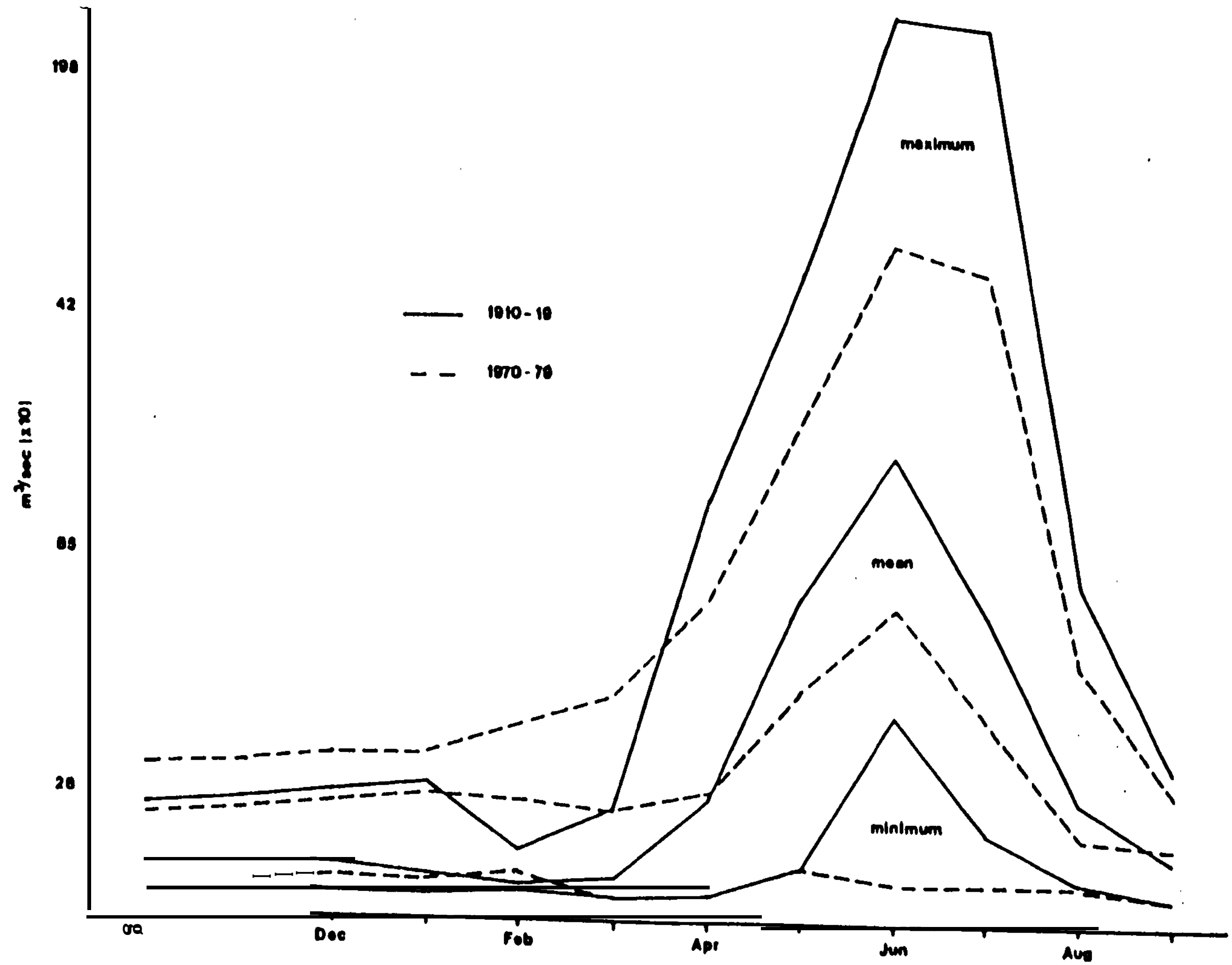


Figure 2. Pre– (solid lines) and post-impoundment (broken lines) average annual flows for the Lower Flathead River recorded directly below Kerr Dam (RK 114.9) at the USGS gauge station established in 1907.

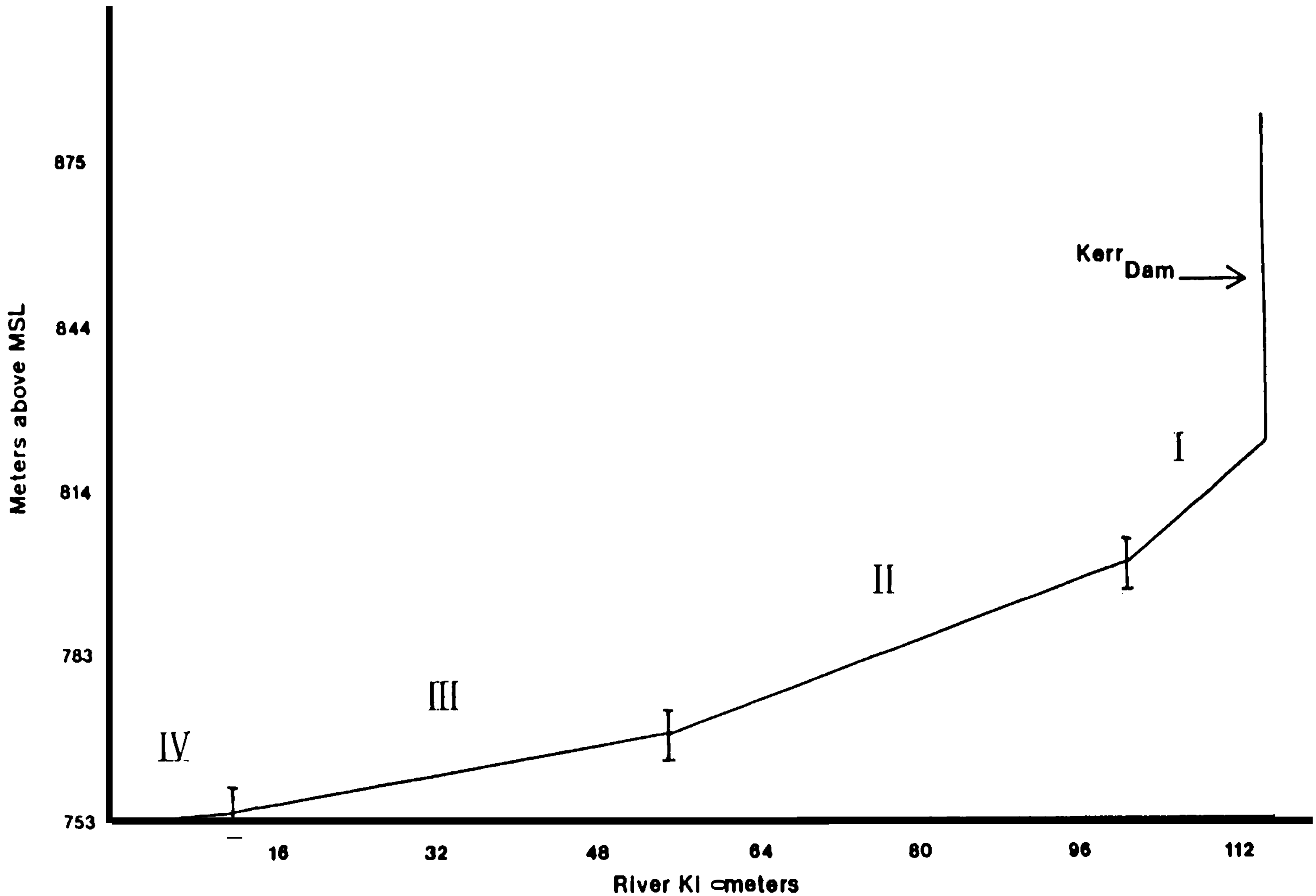


Figure 3. Lower Flathead River profile, with reach breaks indicated.

Reach II of the river extends from the mouth of White Earth Creek (RK 102) to 2 km downstream of Moss's Ranch (RK 54). Average gradient and average river width within this reach are 0.6 m/km and 128 m, respectively. Throughout this river gradually widens, but maintains a single channel. With the exception of a few small islands and constrictions of the river channel, the flow is a smooth glide. Major tributaries enter this reach at RK 72 (Little Bitterroot River) and RK 67 (Crow Creek).

The reach is typified by large meandering bends bordered by high eroding clay cliffs. River banks are generally steep with benchlands beyond; the channel substrate ranges from solid bedrock to sizeable areas of siit deposition.

Reach III of the river extends from RK 72 to RK 12. Average gradient and river width within this reach are 0.3 m/km and 104 m, respectively. Habitat is variable, and the river channel is braided. Major island complexes, gravel bars, and extensive backwater areas are common. Permanently wetted backwaters range from 0.4 to over 12 hectares. River banks area most notably overgrazed and unstable within this reach. Water level fluctuations are less pronounced than in Reach I or II, but may vary as much as 0.3 m in six hours at the bridge near Dixon, montana (USFWS unpublished data).

The fourth river reach extends from RK 12 to the confluence with the Ciark Fork River. The final 6 km of the lower Flathead River are outside the Flathead Indian Reservation boundary. Average gradient of this reach is 0.2 m/km.

The valley walls rise steeply and force the river into a single channel. One small, mid-channel island and one usually dewatered channel are present. With the exception of one bedrock intrusion, substrates are primarily gravels with sizeable areas of sand and silt deposition.

MATERIALS AND METHODS

Phvsical Habitat Evaluation

River kilometers and gradients were calculated using the River Mile Index (Hydrology and Hydraulics Committee 1976). River widths were determined using the Lower Flathead Fishery Investigation report (Peterson 1979) or were taken from aerial photographs. Macrohabitat parameters: pool and riffle areas, pool depths, bank instability and sloughing, and areas of aquatic vegetation, were collected during the summer. Staff gages were installed in two lower river backwater areas (RK) 23 and 191 to monitor water level fluctuations. These gages were usually read once a day during the northern pike spawning period. Daily water level fluctuations at other specific spawning areas were calculated by:

1. taking daily minimum and maximum stage height readings, recorded directly below Kerr Dam (USGS, unpublished data).

2. converting from stage heights to discharge (USGS, unpublished data).

3. comparing discharge to cross-sectional data (USFWS, unpublished data).

4. computing vertical changes in water surface at RK 23 and RK 19.

Channel substrate was mapped using guidelines set forth by the Cooperative Instream Flow Service Group (Bovee 1978). Channel substrate composition was compared to the 50 percentile levels of the probability-of-use curves to determine the total potential area suitable for salmonid spawning. This mapping will compliment future flow modeling using Instream Flow Incremental Methodology and will aid in identifying those areas which could be suitable for salmonid spawning.

Daily flow records for the lower Flathead recorded at RK 115 were provided by the USGS. Flow recording at the USGS station began in August of 1907.

Study Site Selection

Permanent study sections (6.4 km long) for stock assessment were selected on the basis of accessibility and overall representation of the entire river reaches.

Technique Selection

Mainstream and backwater areas of the lower Flathead River were experimentally electrofished using boat-mounted electrofishing gear (Loeb 1957). Electrofishing efforts were conducted during the day and night to identify target fish species distribution throughout the river and determine the methodology to be used in sampling. All target fish greater than 250 millimeters (mm) total length (TL) were number-tagged to determine movements and fisherman exploitation rates. Several backwater areas were experimentally gill-netted using 38 m long nets. Square mesh size ranging from 19 to 51 mm in five 6.5 m panels. Nets were set for two to four hours to avoid fish mortalities. Experimental gill nets and free-drifting gill nets were unsuccessfully tried in the main river.

Backwater and slow-moving mainstem areas were seined to capture young-of-the-year fish and identify areas where target fish species were rearing. A 30 m bag seine and a 15 m straight seine, both with a square mesh size of 6.5 mm, were employed.

Fish captured by various methods were weighed to the nearest 0.01 kilogram (kg) if less than five kilograms. Fish heavier than five kilograms were weighed to the nearest 0.1 kg. Only total length (TL) was measured. All fish were measured to the nearest millimeter. Condition factors (K_{TL}) were calculated using formulae described by Bagenal (1978). Scale samples were taken from all fish for future age and growth analysis.

All target fish species greater than 250 mm were tagged with individually numbered Floy "T-tags" inserted with a tagging gun. Tags were placed just under the dorsal fin. Target species between 100 and 250 mm (TL) were tagged with individually numbered fry tags inserted just anterior to the origin of the dorsal fin using a needle and thread.

Spawning Surveys

The inlets of ten potential northern pike and largemouth bass spawning areas were trapped from March 22 to May 23, 1983 using 1.2 meter diameter double-throated hoop nets and box traps. Experimental gill nets were used to capture spawning northern pike. Nets were set for relatively short periods, usually two to four hours. Target fish were also collected periodically using boat-mounted electofishing gear.

Fisherman Exploitation Rates

The survey being utilized is a modified version of that employed by the Montana Department of Fish, Wildlife and Parks (MDFWP) following the procedures of Neuhold and Lu (1957). Data obtained will be compiled and analyzed using a computer program developed by MDFWP.

The survey began April 1, 1983 with one creel clerk. Survey days were selected using a random-number generator to include weekend and weekdays with no true pattern of survey. On July 7, 1983, six creel clerks were added. The survey is designed so that four clerks work every day (ten hours) of the week, except Tuesday and Thursday when only two people are working. This schedule gives the best coverage for the weekends without neglecting weekdays.

Water Temperatures

Water temperatures were recorded at permanent sites along the entire length of the lower Flathead River using continuously recording 90 day Ryan thermographs installed at Sloans (RK 72), Dixon (RK 40) and Perma (RK 18) bridges. Daily temperatures recorded at the USGS gage house directly below Kerr Dam, (RK 115) are also monitored.

RESULTS

Habitat Evaluation

Within the four river reaches previously discussed in "Description of Study Area", five permanent study sections, 28 percent of the lower Flathead River will be sampled.

Analysis Substrate

Based upon substrate observations made throughout the lower river, 31 percent may have potential as trout spawning habitat. Sixty-nine percent may have potential as mountain whitefish spawning habitat. Sixty-four hectares may have potential for northern pike and largemouth bass spawning.

Many potential spawning areas for trout were observed to be severely degraded due to compaction with silt or fluctuating water depth and velocity. Based upon the relative abundance of mountain whitefish to trout, present spawning conditions must favor the less specific requirements of mountain whitefish. The availability of areas for pike and bass spawning is completely dependent upon releases from Kerr.

Kerr Dam Flow Releases

Kerr Dam is essentially a run-of-the-river facility, and the lower Flathead's annual hydrograph is similar to the flow regime of pre-impoundment days (Figure 2). High run-off flows, however, have been diminished. Regulation of the river decreased high, mean, and low average run-off flows by 25, 32, and 79 percent, respectively. Winter flows, on the other hand, have been dramatically increased. Average increases from November through February for high, mean and low flows are 65, 145 and 56 percent, respectively.

Kerr's power peaking mode of operation greatly effects the daily water level fluctuations occurring in the river. Representative daily fluctuations in discharge from Kerr Dam for water year 1982 are given in Figure 4.

Average monthly low, mean, and high river water temperatures recorded directly below Kerr Dam during 1982 are given in Figure 5.

Based on 1983 temperature recordings, river water temperatures warm approximately one to two degrees C from

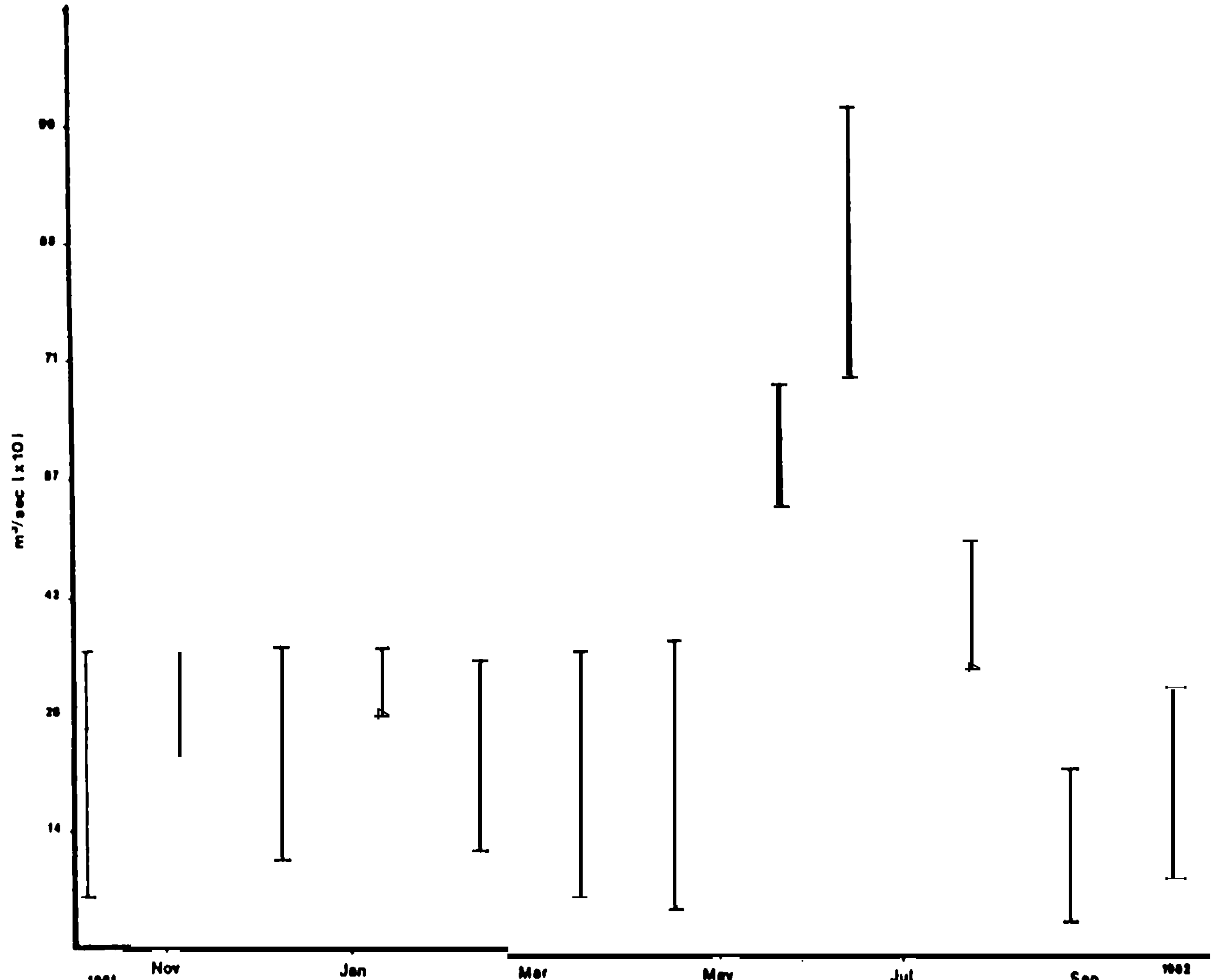


Figure 4. Representative monthly discharges from Kerr Dam for water year 1982 recorded directly below the facility (USGS unpublished data). Daily range and mean discharges for one random day each month are given.

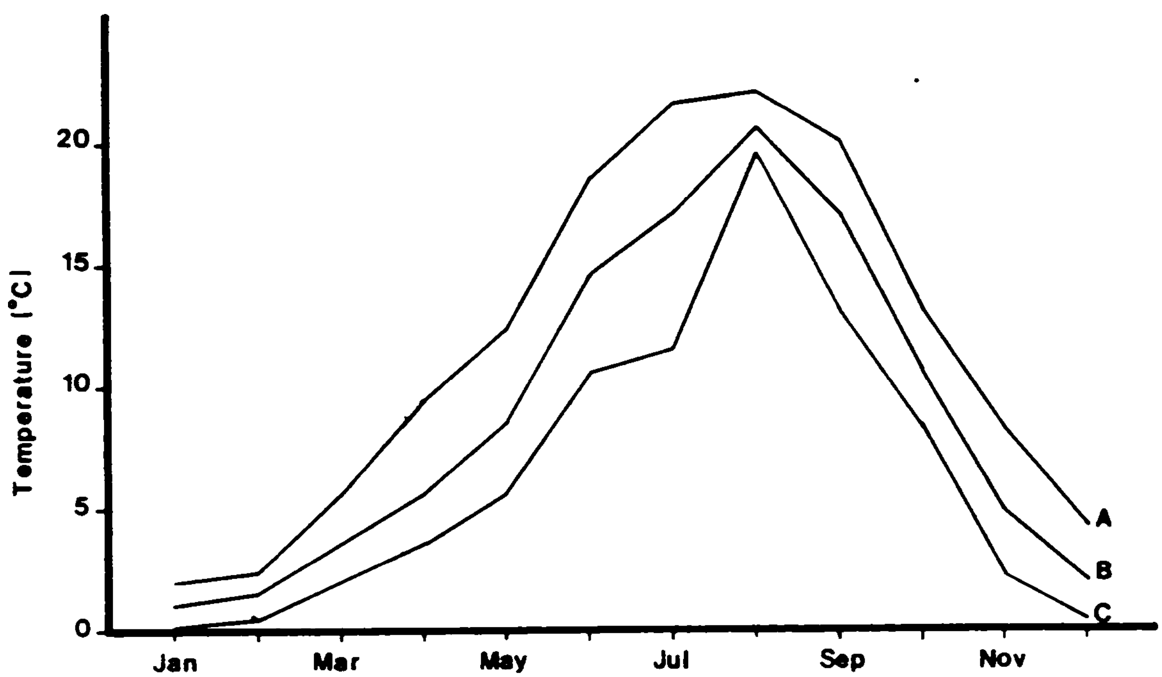


Figure 5. Water temperatures [monthly maximum(A), mean(B), and minimum(C)] for the Lower Flathead River recorded directly below Kerr Dam during 1982 (Shields et al. 1982 and 1983).

the USGS gage house (RK 115) to Sloans bridge (RK 72) during the summer months. From Sloans bridge to Dixon Bridge (RK 40) river temperatures cool about two degrees C due to tributary influence. From Dixon bridge to Perma bridge (RK 18) temperatures again warm to a level comparable to the Sloans area.

Target Species Distribution

Mountain whitefish, brown trout, and northern pike have been collected throughout the length of the river (RK 0 to RK 109). Rainbow and cutthroat trout have been collected up to RK 106, but appear to be more numerous in the lower reaches of the river. One bull trout was collected near RK 27. Largemouth bass have been collected as far upstream as RK 54, primarily in backwater areas.

Two species collected this year, not previously reported for the lower Flathead River, were lake whitefish (*Coregonus clupeaformis*) and yellow bullhead (*Ictalurus natalus*). Lake whitefish were collected in and around Foust Slough (RK 50) and the Knowles dam site area (RK 6). Yellow bullhead were collected in a backwater area at RK 34.

Northern pike and largemouth bass are primarily backwater residents, with largemouth bass being more so than northern pike. Several tag returns indicate movement between backwaters and the main river; two northern pike traveled 1 km and one largemouth bass traveled 3 km.

All three moved from one backwater area to another. Northern pike are commonly found in slack-water areas along the entire course of the river, far from any true back-water type.

Spawning Surveys

Four of the ten potential northern pike spawning areas trapped this spring produced spawners in varying stages of reproductive condition. Gill net sets and seining operations identified four additional areas being used by spawning fish.

One hundred twelve northern pike were captured and tagged between March 22 and June 1, 1983; 41 percent (46) were immature at the time of capture, 14 percent (16), apparently adults, could not be sexed and were most likely females. Of the mature spawners captured and sexed, 30 percent (33) were males and 15 percent (17) were females, yielding a male-female sex ratio of 1.9 to 1.0 (Table 1).

The first ripe male northern pike was collected on April 7, and the first ripe female on May 3, 1983. Both of these fish were captured in the Dixon area. By April 28, 2/3 of all male pike handled were partially spent. Ripe females were collected throughout the month of May, and a fisherman reported catching a female on June 19 still laden with eggs.

Table 1. Method of capture, numbers, reproductive condition, average length, and condition factors (KTL), for nothern pike captured from March 22 to May 23, 1983.

Capture Method	Northern Pike Immature	Male	Female
Netting	38	18	4
Electrofishing	18	5	56
Trapping	6	10	7
Total	62	33	17
Average length (mm) (range)	387.2 (277-490)	686.2 (457-877)	698.8 (594-964)
Average K_{TL}	0.7282	0.8012	0.9011
Standard deviation'	0.0749	0.0822	0.0813

Northern pike were trapped entering shallow areas where the remains of last year's aquatic vegetation (cattail (*Typha latifolia*), horsetail rush (*Equisetum* sp) and bulrush (*Scirpus acutus*)), had been recently resubmerged. Northern pike captured in deeper water areas were over aquatic vegetation consisting of last year's dead and newly emerging *Elodea*, *Potamogeton*, *Char-a*, and *Ranunculus*.

Observations during 1983 indicate known spawning areas are subject to daily water level fluctuations from 0.4 to 1.5 m. A change of only 3 cm at some sites can change inflow to outflow at the mouths of some spawning areas. Daily discharge fluctuations at RK 114 are presented in Figure 6a. Daily river surface fluctuations at RK 30 are presented in Figure 6b.

Largemouth bass spawning activity was not thoroughly monitored this 1983. Snorkling equipment (wetsuits) needed to properly survey nest construction was not budgeted for 1983. Ripe male and female largemouth bass were first captured on May 24 at RK 21. Based on the reproductive condition of the fish, spawning activity continued throughout June at RK 18.0 and RK 21.0. Electrofishing fishing proved to be the most effective method for capturing largemouth bass.

Main river salmonid spawning was not investigated this year because of time constraints. No redds were observed during other river work.

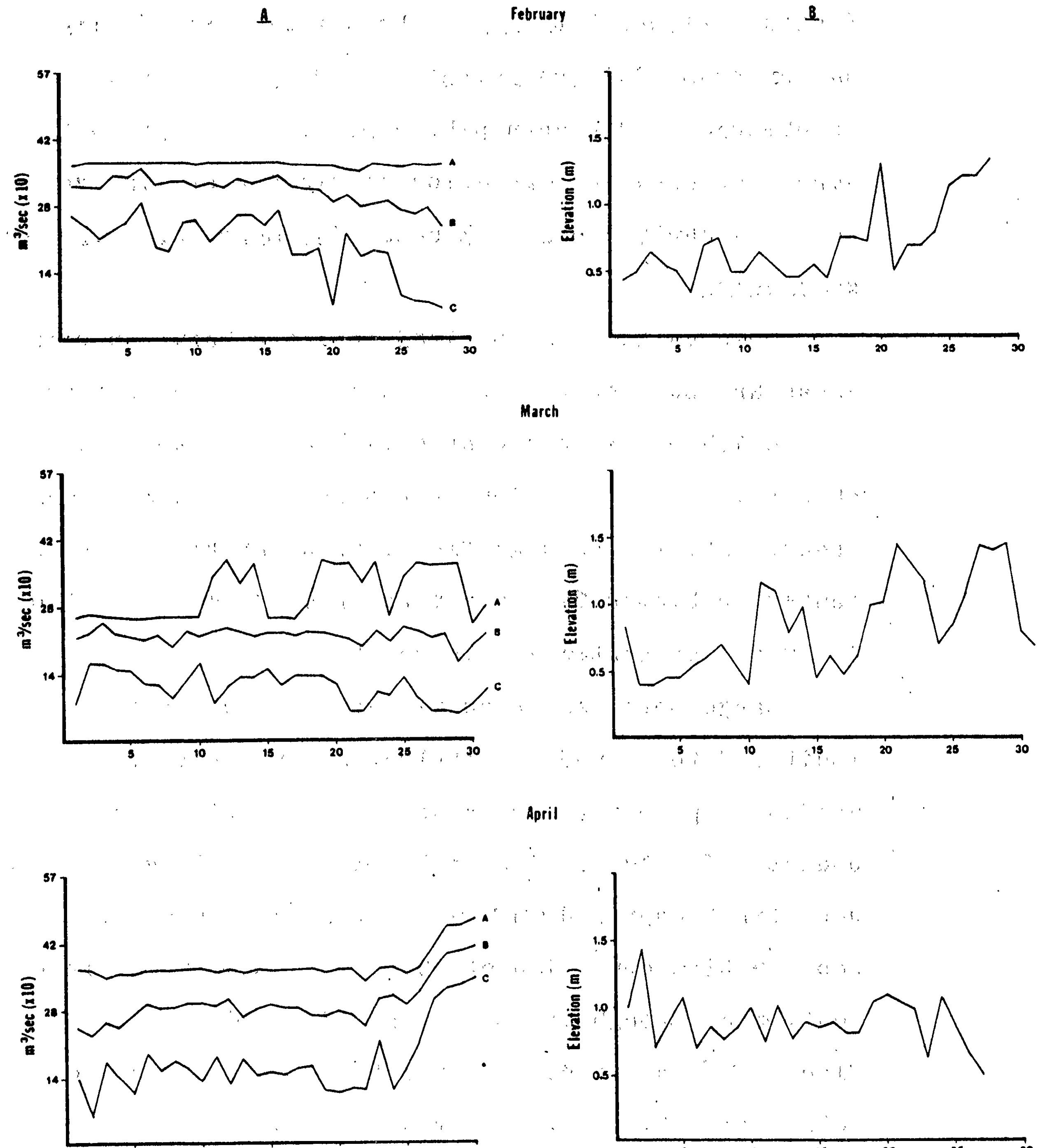


Figure 6. a) Daily discharges [maximum(A), mean(B), and minimum(C)] from Kerr Dam for February, March, and April 1983 recorded at RK 114.9. (USGS unpublished data). b) River surface elevations calculated at a northern pike spawning marsh (RK 20.0, USFWS, unpublished data) for the same period.

Mountain whitefish mesolarvae ranging from 15 to 22 mm TL, were collected on March 16, 1983 in two backwater areas at RK 37 and RK 38. River water levels had recently dropped in this area dewatering the inlets of these backwaters and stranding thousands of whitefish fry in small isolated pools and inlet channels. After hatching, mountain whitefish are about 12 to 13 mm TL. Samples of larvae sent to the Larval Fish Laboratory in Fort Collins, Colorado, were estimated to be two to four weeks old (inter-office transmittal dated 25 March 1983 from Darrel E. Snyder, Larvel Fish Laboratory, Colorado State University, Fort Collins, Colorado). Cyprinid, catostomid, and percid fry were also found stranded in these backwaters.

Seining operations were conducted primarily to identify target fish species rearing areas along the river. Mountain whitefish young-of-the-year were only collected from RK 30 to RK 38. Yearling mountain whitefish seem to be evenly distributed throughout the river, mainly in shallower, lower velocity areas along the shore. No other salmonid fry were collected.

Largemouth bass yearlings are restricted to backwater areas, and were collected at RK 34, 49 and 50. Several northern pike young-of-the-year were collected in a small backwater area at RK 49 and a slack-water area (RK 72) just below the mouth of the Little Bitterroot River (RK 72).

During late spring and summer aquatic vegetation limited the efficiency of seining operations.

Fisherman Exploitation

From March 1 to September 30, 1983, 399 target fish were tagged to assess fisherman returns. One hundred fifty northern pike were tagged, and ten tags were returned; of 22 brown trout tagged, two tags were returned. These tag returns yield an eight month return rate for nothern pike and brown trout of 7 and 9 percent, respectively. One brown trout tagged on June 15, 1983 near Perma (RK 11.2) on the lower Flathead was captured in the Jocko River near Ravalli, traveling 49 km upstream from main river to tributary in 73 days. No tags from mountain whitefish (115 tagged), largemouth bass (95), rainbow (13), cutthroat (3), or bull trout (1) have been received.

DISCUSSION

Physical habitat types in the lower Flathead are varied, suiting the needs of a wide variety of fish species. Five salmonid species are found in the lower Flathead. It also supports largemouth bass and northern pike, two basically lacustrine species. Sever, species of forage fish, primarily catastomids and cyprinids, inhabit the river and support the piscivorous species.

Sediment problems, due to erosion, vast areas of mass wasting, and irrigation returns, direct and via tributaries, reduce the quality of the habitat. Overgrazing, river bank trampling, and loss of riparian vegetation due to livestock add to the sediment problems of the river. Continuous water level fluctuations due to power peaking operations, similar to wave action in lakes, increase bank sloughing and aggravate sediment problems. This phenomenon has been reported by Brusven and MacPhee (1977) on the Snake River in Idaho.

Aside from minor gradient differences, river Reaches I, II, and IV are similar habitat types. Reach III has the most diversity in habitat types. Island complexes, braided channels and large permanent backwaters are present. Lake whitefish are found in Reach III, usually associated with these backwaters or other slow moving river sections. Apparently from Flathead Lake, these fish must have successfully passed the Kerr facility and found adequate habitat to survive. It is not known if lake whitefish are reproducing or hybridizing with mountain whitefish in the main river.

Adequate areas of suitable salmonid spawning gravels exist in the river; degradation due to substrate armoring and siltation are also evident throughout the river. Baxter (1977) found substrate armoring to be a common effect of hydro-power development. Relative abundance of salmonid fish species may reflect available substrate type and its quality; mountain whitefish, basically broadcast spawners are the most abundant salmonid present. Brown, rainbow, cutthroat, and bull trout (redd builders) are relatively uncommon. The low-gradient, low-velocity habitat of the lower Flathead, brown trout's relatively low suceptibility to fishing pressure, and the varied forage-fish food base (Appendix A) probably gives them a competitive edge over other trout species (verbal communication on 20 October 1983 with Calvin M. Kaya, Department of Biology, Montana State University, Bozeman, Montana).

The variability of discharges from Kerr, highest in the spring and fall (Figure 4), can negatively affect the spawning success of salmonid spawning. Water depths, velocities, and intergravel flows over and through any trout redds are constantly changing. The dislodgement and stranding of whitefish eggs due to power peaking operations have been documented on the South Fork of the Boise River (White and Wade 1980, Reiser and White 1981). Stranding of whitefish fry observed this spring along the Flathead River creates a post spawning mortality directly due to Kerr operations.

Northern pike spawning movements are influenced by three environmental factors: water temperature, day length, and increasing water levels (Priegal and Krohn 1975). Northern pike actively seek areas of inflowing water for spawning. Fluctuating water levels which reverse flows at spawning site entrances inhibit pike movement. While the aquatic vegetation communities present in the backwaters of Flathead River create suitable pike spawning habitat (McCarraher and Thomas 1972, Forney 1968, Priegel and Krohn 19'75), river surface fluctuations due to Kerr operations create unfavorable conditions for spawning and incubation by dewatering spawning marshes almost daily.

Bryan (1967) reported a one-week spawning season for northern pike, while Priegel and Krohn (1975) report a season of over two weeks. On the lower Flathead, spawning activities continued for several months, which may ensure some spawning success each year. Minimum flows experienced in the river begin to increase during the later part of April and remain high during May and June. The probability of successful spawning would be greater later in the spawning season due to higher water levels and more permanently wetted marshy areas. Observed spawning adult sex ratios are consistent with those reported by authors already mentioned.

Northern pike are the most highly sought after fish species by fishermen in the lower Flathead. The exploitation rate for pike (only 7 percent) is low compared to 31 percent reported from Michigan by Williams and Jacob (1971) and over 50 percent reported by Eeyerle and

Williams (1972). The exploitation of pike in the lower Flathead may be greater than observed, because the number of pike tagged (150) by September 30, 1983 may have been too low to adequately estimate exploitation.

Exploitation of mountain whitefish and largemouth bass appears minimal. Whitefish are not a desirable species to many fishermen, and specific fishing techniques are needed to make whitefish fishing successful. Largemouth bass are only found in a few areas in adequate numbers to support heavy fishing pressure; these areas may be unknown to most fishermen using the river.

TRIBUTARIES
DESCRIPTION OF STUDY AREA

Glacial till and lake bottom sediments from prehistoric Lake Missoula underlie the tributary study area. Much of the runoff from the Mission Mountains descends through porous till at their base into the groundwater, resurfacing in springs found throughout the valley (Morrison-Maierle and Montgomery 1977).

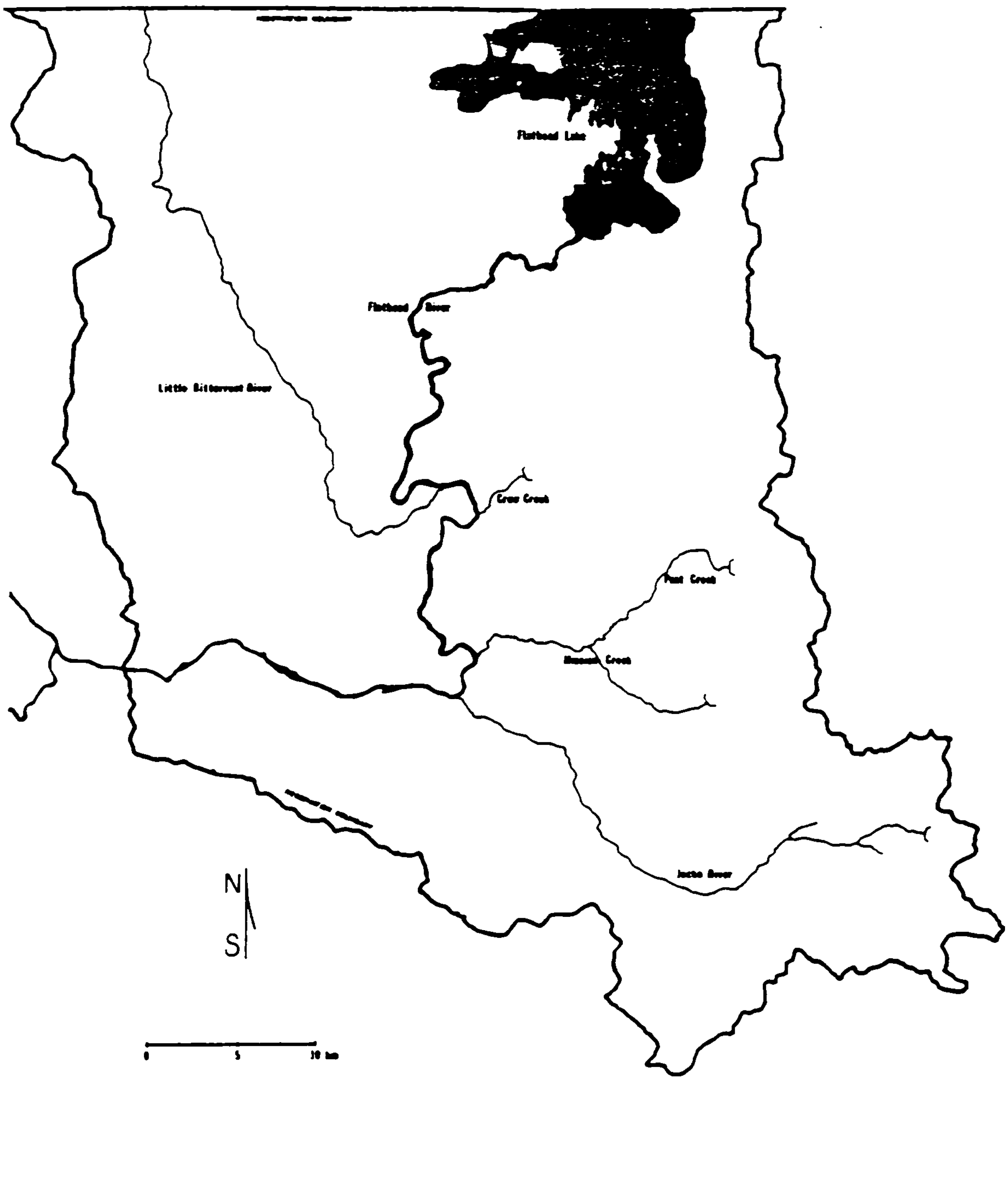
Most of the surface water used on the Reservation is diverted, impounded, and distributed by the Flathead Irrigation Project (FIP). FIP primarily serves three irrigation districts formed under Montana law, but also serves some Tribal and non-Tribal lands within the service area, as well as a few properties that are non-district. In order to supply these irrigation concerns, the major tributaries are impounded at their headwaters or mid-valley and are intersected throughout by canal diversions and irrigation returns. Consequently, the Flathead River tributaries, for the most part, have fair to poor water quality (Nunnallee and Botz 1976), caused primarily by irrigation return flows, agricultural dewatering, live-stock access into streams, and erosion of fragile soils as a result of livestock overgrazing.

The tributary portion of the study is ccnfined to the main stems of five major tributaries: the Jocko River, Post Creek, Mission Creek, Crow Creek, and the Little Bitterroot River (Figure 7). The U.S. Fish and Wildlife Service has overseen fisheries management on the Reservation since 1968 (Peterson 1977). Their management efforts for the five tributaries of interest have concentrated upon allowing the fisheries to be maintained by natural reproduction, although some stocking has been provided.

Jocko River

The Jocko River flows westerly from the Mission Mountains and enters the Flathead River near Dixon. It drains an area of 67,747 hectares, with approximately 12 percent of the drainage under irrigation (Morrison-Maierle and Montgomery 1977). Silviculture and logging activities, along with some residential development, influence the upper drainage water quality. Most years, segments of the river are totally dewatered below Big Knife Creek due to irrigation diversion. Downstream from the town of Arlee, Finley Creek and Valley Creek enter the Jocko, introducing considerable sediment. The lower river flows through hay and pasture lands and is channelized and heavily riprapped along the National Bison Range. Average annual discharge has been estimated as 10.4 m^3/seccnd (Montana State Study Team 1975) and 5.2 m^3/second (Morrison-Maierle and Montgomery 1977).

Figure 7. Main stems of the five major tributaries to the lower Flathead River.



Fish and Wildlife Service personnel from Creston, Montana, sampled the Jocko River for fish periodically throughout the 1970's (Randall 1976; Peterson 1979). Rainbow trout, brown trout, bull trout, and mountain whitefish were found at stations along the 89 km main stem of the Jocko. The Creston Hatchery has planted yearling rainbow trout routinely in the lower Jocko River and occasionally in the upper drainage at least since 1964 (inter-office transmittal dated 4 February 1983 from Larry C. Peterson, U.S. Fish and Wildlife Service, Kalispell, Montana).

Post Creek

Post Creek headwaters are impounded by the McDonald Lake dam. From the outlet the creek flows westerly, picking up irrigation return flows from Pablo feeder canal and Mission "B" and "C" canals, and continues through agricultural land in the Mission Valley before flowing into Mission Creek just east of the National Bison Range. Post Creek's average annual flow of about 2.5 m^3/second (Montana State Study Team 1975) is subject to direct regulation for use in irrigation. Much of Post Creek is turbid year-round due to irrigaticn returns.

United States Fish and Wildlife Service sampling (Peterson 1979; indicates that rainbow trout, brown trout, brook trout, and mountain whitefish inhabit Post Creek.

Mission Creek

Mission Creek headwaters are impounded by Mission Dam. From Mission Reservoir the creek flows westerly through St. Ignatius; three canals (Pablo feeder canal and Mission "B" and "C" canals) intercept its flow. Between St. Ignatius and its confluence with Post Creek, the stream receives sewage-lagoon and irrigation returns, and travels through marshy and agricultural lands. Downstream along the Bison Range, Mission Creek receives agricultural return, feedlot runoff, and intermittent discharges from Charlo sewage lagoons via Dublin Coulee. Hillside Reservoir overflow, composed entirely of irrigation return flow and agricultural runoff, enters the creek just below the Bison Range. The stream then winds through an erosive clay-bank canyon and receives Moiese Valley irrigation return before reaching the Flathead River. Flows near the mouth may average about 2.04 m^3/second (Montana State Study Team 1975) or 4.7 m^3/second (Morrison-Maierle and Montgomery 1977) and are subject to year-round regulation by the FIP.

The U.S. Fish and Wildlife Service (Peterson 1979) found rainbow trout and mountain whitefish in Mission Creek below its confluence with Post Creek. Electrofishing sampling by Riggs during 1981 (unpublished data) above Post Creek showed that rainbow trout, brook trout, and mountain whitefish are present in upper Mission Creek.

Crow Creek

North and South Crow Creeks flow west from the Mission Mountains converging to form the main stem of Crow Creek approximately one mile east of Highway 93. Above Lower Crow Reservoir two major tributaries, Ronan Spring Creek and Mud Creek, bring urban stormwater runoff and irrigation runoff and returns to Crow Creek. Lower Crow Reservoir is used to store irrigation water for the Moiese area. Only the 6 km stream section below Lower Crow Dam is being surveyed for this study. Flows below the dam are regulated by Lower Crow Dam and a major irrigation diversion approximately 2 km below the dam. Historically, the creek flow would be withheld completely during a normal irrigation year (Morrison-Maierle and Montgomery 1977); however, some stream flows are now being maintained year-round. High spring runoff occasionally prompts large releases from the reservoir, causing mass wasting, scour, and debris movement in Crow Creek. Average annual flows are 2.4 m^3/second (Montana State Study Team 1975).

Rainbow trout and mountain whitefish have been captured during previous sampling efforts below the reservoir (Peterson 1979).

Little Bitterroot River

The Little Bitterroot emerges from Hubbart Reservoir north of the Reservation boundary and flows south through a narrow wooded canyon. Most of the flows are intercepted and diverted into Camas "A" canal at the canyon mouth. The remaining flow continues south through the arid Camas Prairie and Little Bitterroot Valley, cutting through generally heavy, poorly-drained, erosive, alkaline soils. Sullivan Creek contributes hard-rock mine runoff and sediment to the upper river; Hot Springs Creek is a major sediment source further downstream. Low rainfall and overgrazing have limited vegetation cover and aggravated serious erosion problems throughout the drainage. Consequently, the Little Bitterroot is turbid year-round and contributes considerable sediment to the lower Flathead River. Average annual flows have not been reported; however, the river is dewatered in several areas by summer irrigation withdrawals.

Northern pike, the primary target species in the Little Bitterroot River, was first collected from this stream during 1961 (Hanzel 1976). Pike probably were first introduced into Lonepine Reservoir in this drainage from Sherburne Lake in Glacier National Park during fall 1953.

MATERIALS AND METHODS

Physical Habitat Evaluation

Several habitat evaluation methods were reviewed, including surveys developed by N.A. Binns (1979) of the Wyoming Game and Fish Department, Duff and Cooper (1976) of the Bureau of Land Management, and T.W. Chamberlin (1980) of the British Columbia Ministry of Environment. The Montana Department of Fish, Wildlife and Parks' (MDFWP) modification of the British Columbia method (Fraley and Graham 1981) was chosen for its suitability to describe the streams found on the Flathead Indian Reservation.

Stream reaches were selected on the basis of marked changes in stream gradient, sinuousity, bank slope, land use, and/or water flow. Reach boundaries were determined using topographic maps, aerial photographs, and helicopter reconnaissance, and were verified on the ground.

One-mile-long habitat survey sections were chosen as segments representative of stream reaches. Measurements of 31 separate physical habitat parameters were measured in each survey section by field crews. These parameters pertained to stream hydraulics, pool-riffle-run ratios, pool class, channel cover and morphology, bed and bank material and stability, debris, and aquatic vegatation (sample form in Appendix B). In addition, the U.S> Forest Service (USFW, 1978) Stream Reach Inventory and Channel

Stability Evaluation (Appendix B) was applied twice during each survey to further describe the habitat. Photo stations were established at the beginning and end of each habitat survey section, and at the mouths of the Jocko River, Mission Creek, Crow Creek, and the Little Bitterroot River.

Measurements of habitat components will be regressed against fish population estimates to help predict fish density based upon habitat types. Correlation coefficients will be run to quantify the strength of the relationship between fish density and each habitat component.

Stock Assessment

Test population estimates were made using the two-catch (Seber and LeCren 1967) or Peterson mark-recapture (Ricker 1975) method. Sampling stations were 150 m long, except one 500 m station run at km 44 of the Little Bitterroot River during June. Estimates of relative abundance were reported as number of fish per surface area or length of stream.

Tributary streams were sampled using a bank- or boat-mounted electrofishing unit. Depending on stream flows, the 150 m sections were enclosed either by nylon or wire block nets, as described by Shepard and Graham (1983), or left open.

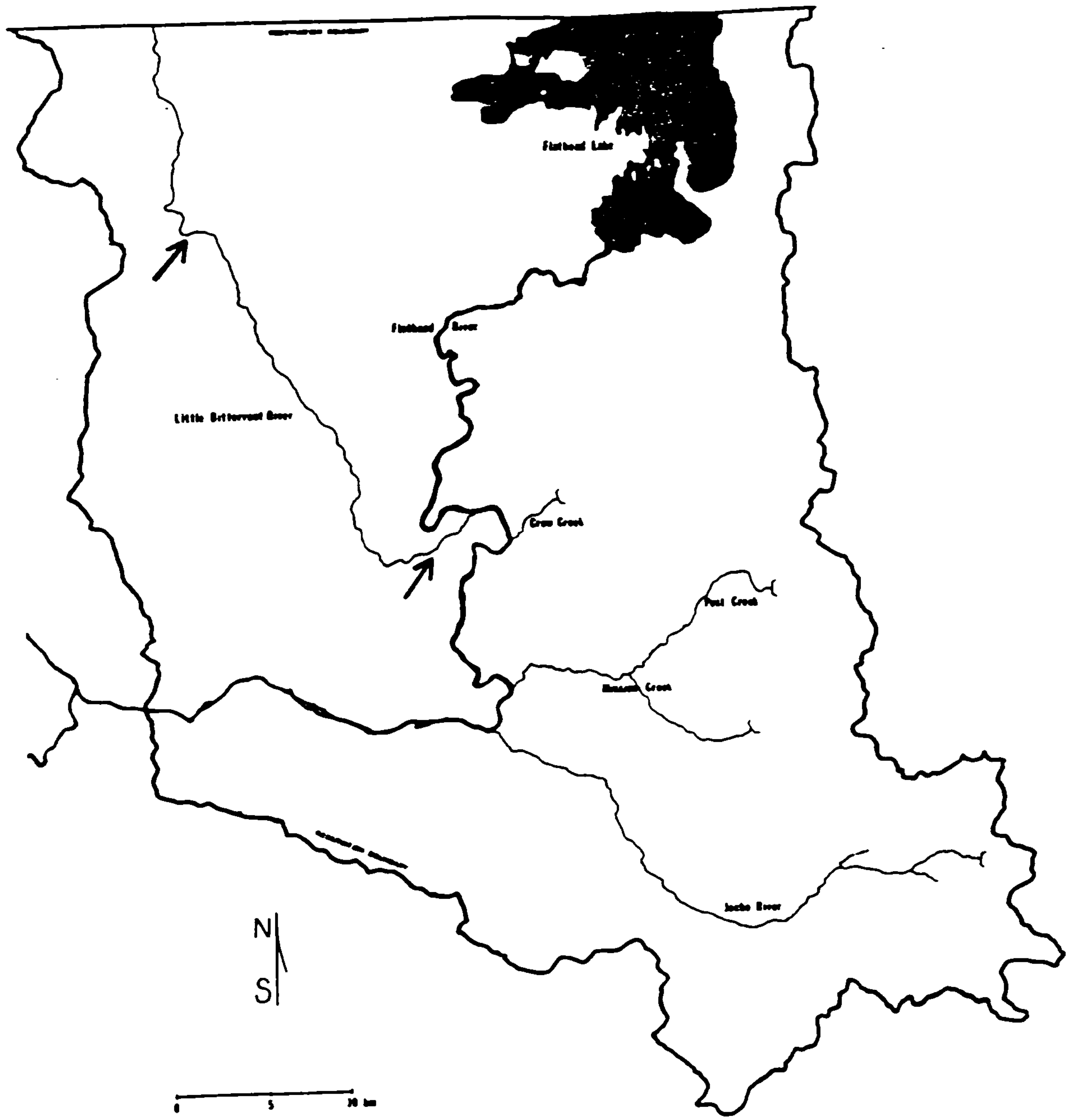
Target fish collected during this year were measured, weighed, and marked or tagged with fingerling or floy tags. Scales were removed and later impressed into cellulose acetate. Tag return requests were posted at public locations, circulated in local newspapers, and distributed to fishermen by creel census clerks. Analysis of collected data provides information on fish abundance, condition, age and growth, and movement.

Permanent stock assessment stations representative of each reach were selected at sites with good equipment access within the habitat survey sections.

Spawning Surveys

Trout redd surveys were conducted during April and May. Starting time for each survey was noted, and time elapsed to each located redd was recorded. Proximity of a redd to left bank, right bank, or channel center was described. Tributary mouths were electrofished during spring to determine timing of rainbow or cutthroat trout spawning runs. In the Little Bitterroot River, spawning northern pike were captured near Lonepine (km 60, Figure 8) using nylon fyke nets with nylcn leads, and near the mouth (km 5) using steel hoop traps with wire leads. At both locations, upstream traps were set to capture spawning adults, and downstream traps to capture spent spawners. Suspected spawning areas near Lonepine were

Figure 8. Trap sites on the Little Bitterroot River.



electrofished for adults and young-of-the-year using bank and backpack electrofishing units. Several areas below Lonepine and one area below the lower trap were electrofished to determine movements of tagged pike.

Captured fish were measured, weighed, checked for ripeness, and tagged with floy tags. Scales were removed and later impressed into cellulose acetate.

Weirs

Potential weir sites on the Jocko River, Mission Creek, Crow Creek, and the Little Bitterroot River were investigated. Sites were selected based upon channel straightness, stream bank and bottom stability, and access for construction and operation. Hydraulic engineers from the Montana Department of Highways were consulted about the hydrologic integrity of each site using the proposed weir design.

Adjacent landowners and concerned agencies were contacted to obtain permission to build at the Jocko River and Mission Creek sites. Bids were solicited from contractors to estimate costs for construction and installation of weirs and traps.

Fisherman Excioitation Rates

Many of the tributaries were surveyed as part of a genera: creel census conducted on streams and reservoirs on the Flathead Indian Reservation during 1983. This survey was adapted from procedures outlined by Neuhold and Lu (1957). One creel clerk began the survey on 1 April 1983, six clerks worked during the summer, and three are continued through fall on a random schedule.

Information on fishing methods, effort expended, and fish species caught was collected. Fish from creels were measured and checked for ripeness; scale samples were taken. Compiled data is being analyzed using a computer program developed by MDFWP.

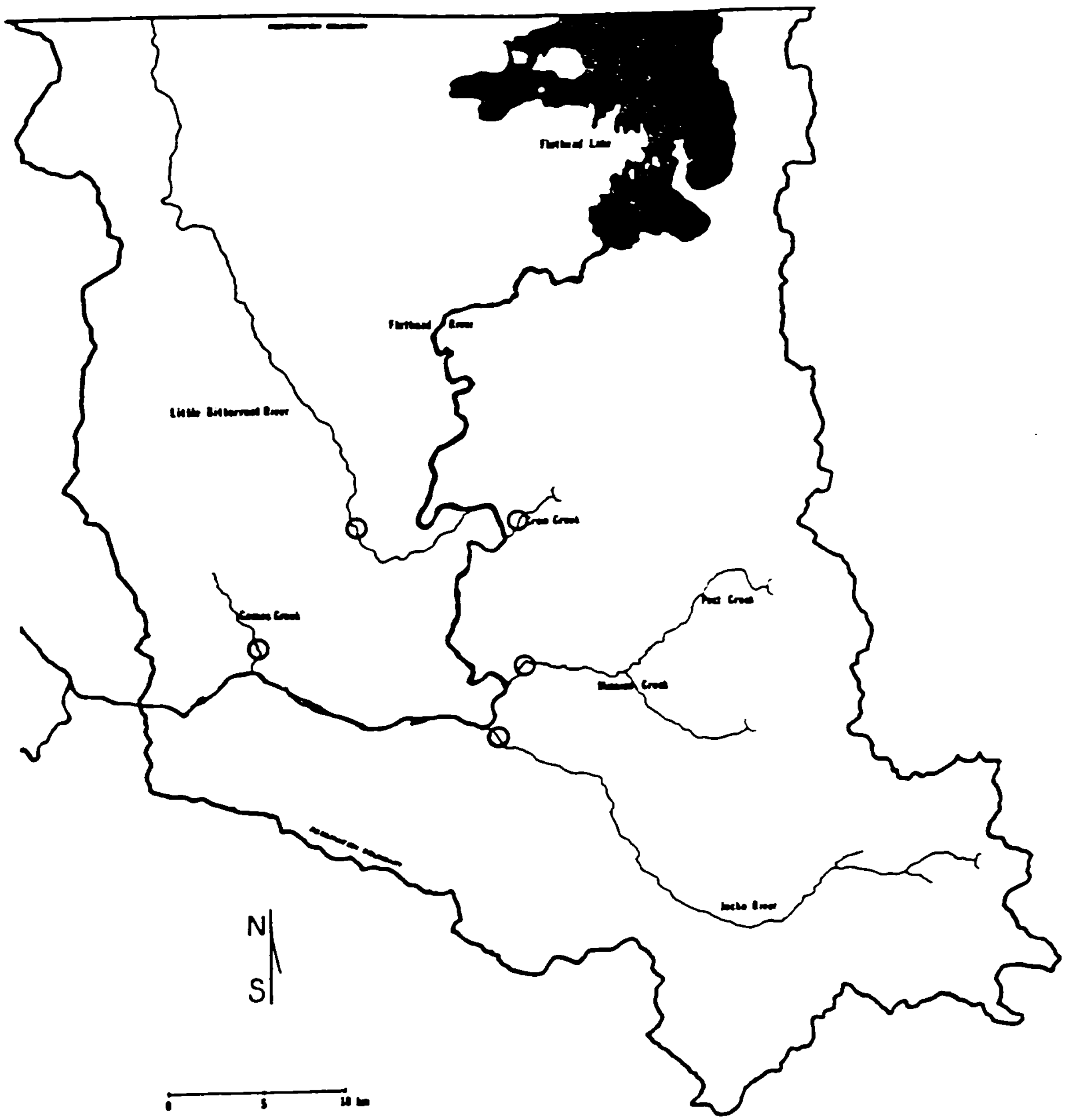
Tag ‘returns from fishermen provided an estimate of harvest rates for fish tagged in the tributaries.

Water Temperature

Continuously recording, 90-day thermographs were installed near the mouths of five tributaries (Figure 9): the Jocko River, Mission Creek, Crow Creek, Little Bitterroot River, and Camas Creek.

Flows were recorded periodically in conjunction with habitat surveys and stock assessment surveys. Measurements were taken directly using an electronic flow meter, or stage heights were read at established hydrologic stations and translated into flows using provisional rating curves developed by Tribal hydrologists. U.S. Geological Survey methods (Carter and Davidian 1968; Buchanan and Somers 1969) were followed in metering flows.

Figure 9. Thermograph sites on five tributaries to the lower Flathead River.



RESULTS

Habitat Evaluation

The main stems of five major tributaries to the lower Flathead River were divided into 22 reaches (Figure 10): seven on the Jocko River, five on Mission Creek, four on Post Creek, one on Crow Creek, and five on the Little Bitterroot River. Reach lengths ranged from 2 km for Post Creek reach 1 to 39 km for Little Bitterroot reach 2. Reach boundaries and locations of habitat survey sections within these boundaries are described in Appendix C.

Stream habitat characteristics for the 22 reaches are summarized in Table 2. Four of the major tributaries: Mission Creek, Post Creek, Crow Creek, and the Little Bitterroot River, rated fair based on the USFS method for evaluating stream channel stability; the Jocko River rated as good; none rated as excellent. Factors such as turbidity, lack of pools and/or riffles, and siltation of spawning gravels further degraded many tributary reaches.

Jocko River

Runs were the predominant stream feature throughout the Jocko River's seven reaches (Table 2). Pools were seldom intersected by survey transects. One pool was noted in reach 2; twelve in reach 5.

Erosion problems were more common in the Jocko's lower reaches. Areas of mass wasting were frequently encountered in reaches 1 and 2; rip-rap was used along

Figure 10. Reach boundaries established on five major tributaries to the lower Flathead River.

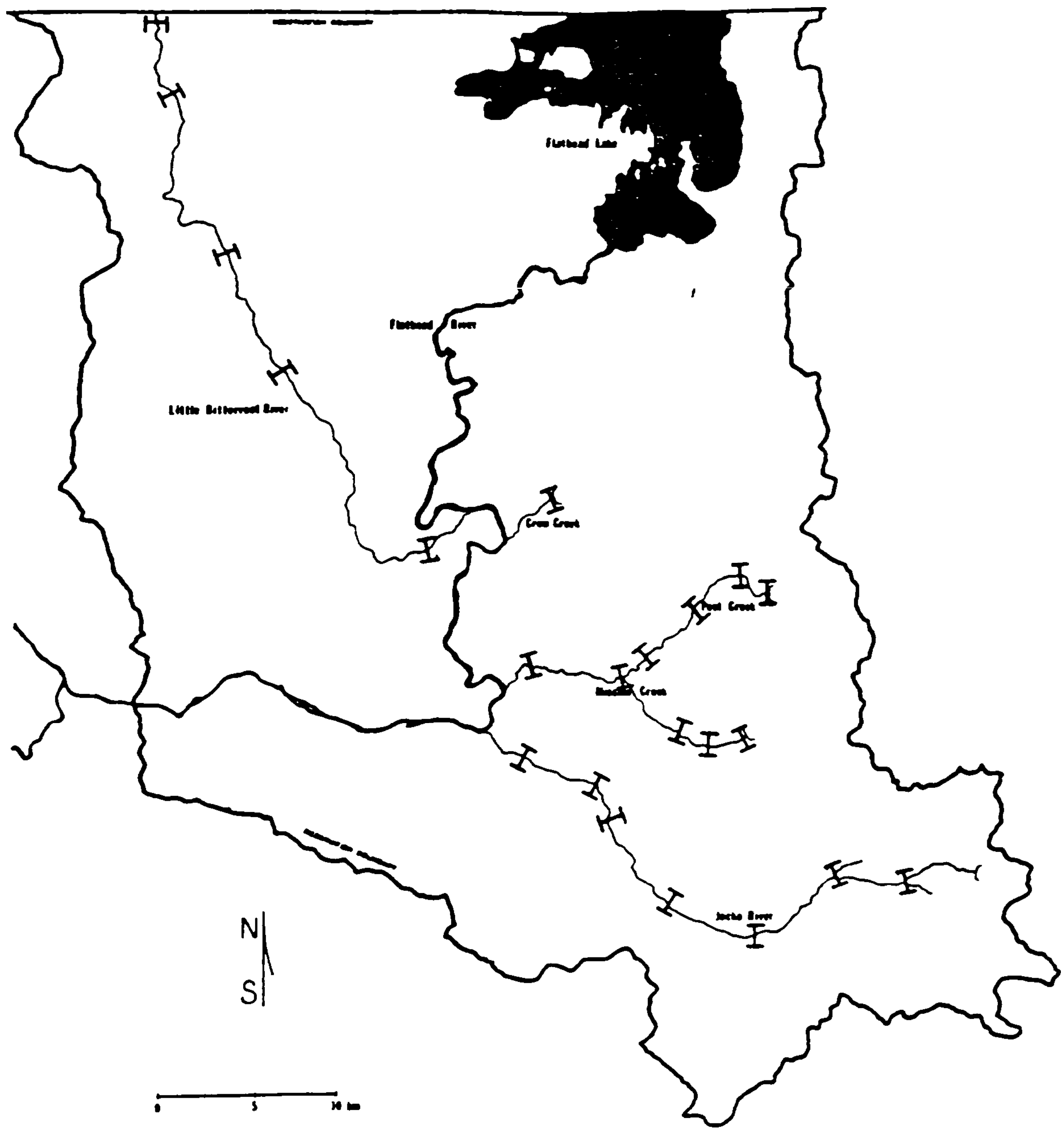


Table 2. Selected habitat parameters measured on tributaries to the lower Flathead River.

Stream and reach	Survey date	Flow (m^3/second)	Hydraulics: Wetted width (m)	Channel width (m)	Average depth (cm)	Feature (%Pool/riffle/run/pocket-water)	Bed material: Texture (%-f,g,c,bo,be)[b]	Bed material: Compaction (n,l,m,h)[a]	Bank material: Texture (%-f,g,c,bo,be)[b]	Stability (e,g,f,p)[c]	Channel cover (%-canopy/overhang/instream)	U S F S rating (e,g,f,p)[c]
Jocko River												
R-1	1 Aug 1983	7.5	21	24	51	0/10/88/2	42/25/21/12/0	m	50/25/18/7/0	f	5/4/8	g
R-2	10 Aug 1983	8.7	20	26	39	0/7/93/0	28/34/28/10/0	l	47/25/25/3/0	g	5/5/1	g
R-3	11 Aug 1983	6.9	20	25	51	3/2/95/0	43/30/23/4/0	l	80/16/4/0/0	g	6/5/2	g
R-4	9 Aug 1983	4.2	19	47	43	0/10/90/0	37/40/23/0/0	l	52/30/18/0/0	f	3/5/3	f
R-5	8 Aug 1983	0.1	11	18	20	3/5/57/35	22/22/26/30/0	h	34/23/28/15/0	g	13/9/2	g
R-6	3 Aug 1983	5.0	17	20	44	0/8/92/0	30/17/25/28/0	h	37/15/20/28/0	g	3/2/2	g
R-7	2 Aug 1983	3.9	12	14	55	5/0/80/15	43/18/15/24/0	h	85/8/4/3/0	g	36/18/15	g
Mission Creek												
R-1	1 Sept 1983	6.8	14	25	59	5/10/95/0	50/35/12/4/0	l	66/22/10/2/0	p	4/3/100	f
R-2	23 Aug 1983	5.1	18	22	65	10/15/75/0	63/24/13/0/0	l	73/18/7/2/0	p	4/4/77	p
R-3	22 June 1983	0.5	7	12	37	13/18/69/0	47/47/5/1/0	m	58/38/3/1/0	f	8/5/4	f
R-4	27 June 1983	1.4	8	10	37	5/5/90/0	38/40/21/1/0	m	63/28/6/3/0	f	9/6/5	g
R-5	15 Aug 1983	3.0	11	17	40	3/0/97/0	33/28/32/7/0	h	68/18/13/1/0	p	24/10/6	f
Post Creek												
R-1	22 Aug 1983	3.1	16	16	53	3/12/83/2	64/25/9/2/0	l	85/13/1/1/0	g	9/10/80	f
R-2	18 Aug 1983	0.6	10	10	51	0/3/97/0	58/38/3/1/0	l	92/8/0/0/0	g	5/5/100	f
R-3	17 Aug 1983	0.1	7	16	20	2/10/88/0	35/20/32/13/0	h	87/6/6/1/0	f	12/22/3	f
R-4												
Crow Creek												
R-1	16 Aug 1983	2.4	9	15	30	8/22/67/3	50/17/23/10/0	m	74/8/14/4/0	p	6/5/35	f
Little Bitterroot River												
R-1	11 July 1983	0.1	10	13	30	3/20/77/0	32/17/25/23/3	h	67/7/6/4/16	f	1/1/100	f
R-2	13 July 1983	0.1	7	9	36	0/0/100/0	99/1/0/0/0	h	100/0/0/0/0	p	1/1/100	f
R-3	7 July 1983	0.3	6	7	40	0/0/100/0	100/0/0/0/0	l	100/0/0/0/0	f	17/23/100	f
R-4	5 July 1983	0.003	16	27	83	0/0/100/0	100/0/0/0/0	n	100/0/0/0/0	e	47/69/100	g
R-5	6 July 1983	0.3	7	10	22	5/18/77/0	37/10/38/15/0	h	77/8/8/7/0	e	31/14/19	g

[a] n = nil, l = low, m = moderate, h = high

[b] f = fines, g = gravel, c = cobble, bo = boulder, be = bedrock

[c] e = excellent, g = good, f = fair, p = poor

railroad right-of-ways and near farm houses in reach 3; and the stream channel was braided in reach 4. In reach 5, banks contained large, stable rocks, and bed material was more compacted. In reaches 6 and 7, the river was confined by a canyon, and increased riparian vegetation helped to further stabilize the banks.

Several areas of spawning gravel were found, particularly within reach 4, between Valley Creek and Finley Creek.

Mission Creek

Below the confluence with Post Creek, Mission Creek flows were high and the water was turbid (Table 2). Mass wasting was common in reaches 1 and 2, and streambed compaction was low. Few pools and riffles were present.

Flows dropped and the water was clear above Post Creek. Reach 3 was characterized by channel shifting; reach 4, by cattle grazing to the water's edge. Despite dense bank vegetation, uppermost reach 5 was scoured and undercut by large releases from Mission Dam. Fallen trees criss-crossed much of the stream.

Post Creek

The predominant stream feature in reaches 1, 2, and 3 was the run category (Table 2). In steeper reach 4, riffles were as prevalent as runs. Turbidity was high in iower reaches 1 and 2, but decreased noticeably in reach 3 above most irrigation returns. Much of the spawning gravel in Post Creek was found in reaches 1 and 2 and was compacted with silt. Mass wasting and rip-rap were common in the lower reaches, especially reach 2. Reach 4, between Mission Dam and Pablo feeder canal, was characterized by stable, tree-lined banks and clear water.

Crow Creek

Crow Creek has experienced large flow fluctuations subject to releases from Lower Crow Reservoir. The stream bed and banks were composed predominantly of fines and gravel (Table 2). Mass wasting, debris jams and high turbidity were common. Spawning-size gravel was common thoughout the reach, but was silt-laden.

Little Bitterrpot River

The British Columbia method of habitat evaluation (Chamberlin 1980) and US Forest Service (1978) inventory were both developed to evaluate trout habitat. These methods were not as applicable to much of the Little Bitterroot River, which is better habitat for northern pike. The uppermost reaches, especially reach 5, had better water clarity, thicker canopy, and larger bed materials. Consequently, these reaches received better ratings using the methods chosen.

Stream flows were low at survey time (Table 2) and dropped further later in summer as temperatures rose and irrigation withdrawals increased. Host of the river was coffee-colored, especially below the head of reach 2 where turbid Hot Springs Creek entered. The turbid water and abundant submergent and emergent vegetation constituted the high instream cover.

Stock Assessment

A total of 22 stock assessment stations (Figure 11) were established for the five major tributaries: seven on the Jocko River, five on Mission Creek, four on Post Creek, one on Crow Creek, and five on the Little Bitterroot River (Appendix C). Trial population estimates were made on sections of three tributaries as described below.

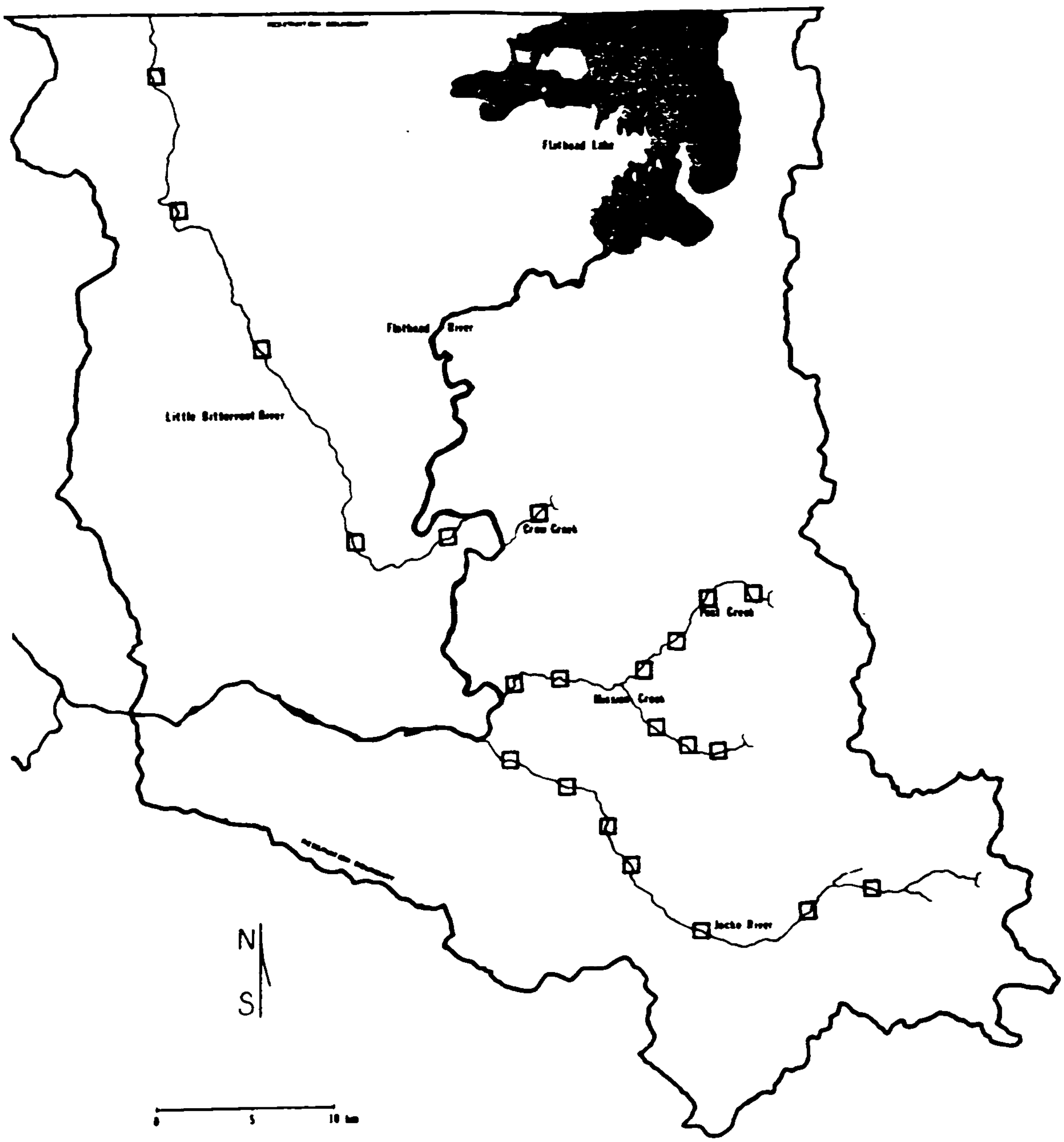
Two-Catch Method

The two-catch method of population estimation was applied to a 500 m section of the Little Bitterroot River from the confluence of Hot Springs Creek upstream. Flows were low enough on May 24 and 25 that nylon block seines enclosing the section could be left overnight. Probability of capture was 0.68; the estimated number of northern pike in the 500 m was 55 ± 7 (80% confidence interval). Pike total lengths ranged from 179 to 625 mm.

Mark-Recapture Methods

The Peterson mark-recapture method was applied to an enclosed 150 m section of Mission Creek above St. Ignatius (reach 4, km 24). The rainbow trout population (TL 65 to 282 mm) was estimated as 127 ± 52, the eastern brook trout population (TL 61 to 270 mm) as 1005 ± 511 (80% confidence intervals). A few mountain whitefish (TL 102 to 203 mm)

Figure II. Stock assessment stations established on five major tributaries to the lower Flathead River.



were captured, but none were recaptured.

An open 150 m section of Crow Creek below Lower Crow Reservoir (km 5) was sampled on August 30 (marking) and September 6 (recapturing). The rainbow trout population (TL 74 to 126 mm) was estimated as 38 $\pm$ 21 (80% confidence interval).

Target Species Distribution

Rainbow trout and mountain whitefish were present in all samples taken thus far from the lower ends of the Jocko River, Mission Creek, and Crow Creek. In addition, brown and bull trout were captured near the mouth of the Jocko River; cutthroat and eastern brook trout from the Middle Fork Jocko River near its confluence with the main stem. Brook trout were also found in Mission Creek above St. Ignatius. Cutthroat, rainbow, and brook trout were collected from the Little Bitterroot River in the canyon above Camas "A" Canal (km 76); only northern pike were found below the canal. A summary of location, date and size range of target species captured is presented in Appendix D.

One brown trout tagged 15 June 1983 in the main river near Perma (RK 11) was captured 73 days later on 27 August in the Jocko River near Ravalli (km 14), having travelled 50 km.

Spawning Surveys

A preliminary survey during April of 6 km of Crow Creek from the mouth to Lower Crow Reservoir revealed 23 trout redds. Rainbow trout eggs were obtained from fresh redds. Larger, darker (older) redds were also present, probably formed by fall spawners.

Ninety redds were found in a survey of the Jocko River from km 18 to km 41 during May. Most of the redds were concentrated within the 12 km between Valley Creek and Finley Creek.

Spawning northern pike in the Little Bitterroot River appeared to congregate in areas with reed canary grass (*Phalaris arundinaceae*), bur-reed (*Sparganium eurycarpum*), cattail (*Typha latifolia*), and bulrush (*Scirpus acutus*). Most of the suitable spawning habitat appeared to be concentrated near Lonepine within a large marsh approximately 59 km above the river mouth.

Trapping started late in the spawning season at the Lonepine marsh; as a result, few fish were trapped entering the marsh. Of the 29 northern pike tagged entering the marsh at Lonepine from March 23 to April 22, 19 (66%) were recaptured returning downstream from April 21 to June 9. An additional 91 spawners were trapped leaving the marsh and are assumed tc have moved into it prio to installing the trap. Turnaround time for marked pike averaged 23.5 days and ranged from 1 to 52 days. Of the 120 pike tagged at this trapsite, 5 tags were returned by fishermen fishing 5 km downstream.

Three nothern pike were captured in an upstream trap set from April 13 to May 4 approximately 5 km above the river mouth. None of these were among the 7 pike captured in an adjacent downstream trap set from April 28 to July 13. .One 760 mm pike trapped on June 23 at the lower trap site on the Little Bitterroot was recaptured by a fisherman 5 km downstream in the Flathead River near Sloans Bridge on July 27.

Northern pike captured during the spawning run in the Little Bitterroot River up to May 31 ranged from 140 mm to 630 mm (TL) and weighed from 20 to 2000 g. Adult pike of the Little Bitterroot River were generally smaller and spawned earlier than pike in the Flathead River.

Weirs

A weir site for the Jocko River was selected 2 km above the river mouth. The straight channel, aggrading stream bottom, and good access for construction equipment supported this selecticn. Hydraulic engineers from the Montana Department of Highways confirmed the site as hydrologically sound. Rip-rapping and streambed reinforcement were recomended.

The Mission Creek weir will anchor on one side to an existing abutment immediately below the Highway 212 bridge, 6 km above the mouth. This site has a straight channel and good equipment access.

The proposed weir sites on Crow Creek and the Little Bitterroot River were abandoned. Crow Creek banks are unstable, and its flows fluctuate widely. A system of metal box traps and wire mesh leads will be used to capture spawning northern pike in the Little Bitterroot River.

The weir design (Appendix E) chosen for the Jocko River and Mission Creek was first developed by Art Dobler, a U.S. Forest Service engineer with the Shasta-Trinity National Forest, California, and was first used on Manzanita Creek, California.

Fisherman Exploitation Rates

Of the 198 northern pike tagged as of 30 September 1983 in the Little Bitterroot River, 17 (9%) were caught by fishermen. None of the 19 salmonids tagged in the Jocko River, Mission Creek, and Camas Creek were reported captured.

Creel census data is being analyzed by Robert McFarland of the Montana Department of Fish, Wildlife and Parks.

Water Temperatures

For the five tributaries (Jocko River, Mission Creek, Crow Creek, Little Bitterroot River, and Camas Creek) monitored by thermographs from March through September 1983, the lowest mean temperatures were recorded during March and the highest during August (Table 3). During six days in August, maximum temperatures in the Jocko River exceeded the 19.4 C criterium set forth by the Water Quality Bureau of the Montana Department of Health and Environmental Sciences (MDHES 1982) for cold-water aquatic life. Mission Creek exceeded this criterium during 11 days in August; Crow Creek during several days in May, June, and July, and most of August; the Little Bitter-root River during part of May and June and all of July and August, as well as and half of September; and Camas Creek during most of May and June and essentially all of July and August.

Table 3. Mean, maximum, and minimum monthly temperatures (°C) near the mouths of 5 tributaries to the lower Flathead River.

Month	Mar			Apr			May			Jun			Jul			Aug			Sep		
Stream	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Jocko River	6	10	3	9	15	4	11	16	6	12	18	9	14	19	10	16	20	12	11	17	7
Mission Creek	7	10	4	10	17	6	12	18	8	15	20	11	15	19	10	17	22	14	12	18	7
Crow Creek	7	9	5	9	16	4	12	20	6	16	22	12	17	22	14	19	24	15	15	21	10
Little Bitterroot River	6	10	3	13	20	8	14	24	8	18	26	14	21	28	15	22	30	16	16	24	6
Camas Creek	6	11	2	11	21	3	15	25	7	18	27	11	19	26	12	19	26	14	13	22	4

DISCUSSION

All of the lower Flathead River tributary streams evaluated are regulated by impoundments and intercepted by diversions to supply water for irrigation. Stream flows may vary from severely restricted, as seen in the Little Bitterroot River, to the flushing flows common on lower Crow Creek. The tributaries also exhibit erosion problems such as sloughing banks, mass wasting, and turbid water.

The Jocko River represents the best overall trout habitat based on the habitat evaluation applied in this study. There is no trout habitat in the lower reaches of the Little Bitterroot River; however, its warm, vegetation-clogged water is well suited to pike.

Stock assessment is necessary before tributary habitat can be related to fish species presence and abundance. Stock assessment results will be correlated with various habitat parameters to isolate those parameters most predictive of target species presence. Combining these analyses with the results of the Instream Flow Incremental Methodology (Bovee 1982) to be conducted during 1985 will allow determination of habitat and flows important to the target fish species.

Statistically valid population estimates were obtained for the tributary streams using the two-catch removal method and mark-recapture methods. The mark-recapture methods applied to open sampling sections are better suited for the deep and fast-flowing water in the lower reaches of all five tributaries. None of the proposed stock assessment stations can be sampled both spring and fall using the two-catch method. The unpredictability of flows in streams regulated for irrigation alone makes the single or multiple mark-recapture methods more repeatable and reliable.

Preliminary results indicate that trout migrate from the lower Flathead River up the Jocko River. One tagged brown trout captured near Perma on the Flathead River, was captured in the Jocko River near Ravalli. A cutthroat trout tagged during April 1979 at the mouth of Revais Creek, also was found in the Jocko River near Ravalli during July (Peterson 1979).

Northern pike migrate between the Little Bitteroot River and the lower Flathead River. One northern pike released from a downstream trap in the Little Bitterroot River 5 km above the mouth was recaptured in the main river. The extent of these inter-river exchanges is unknown.

Both spring and fall spawning trout use lower Crow Creek. Several redds noted during the April survey were larger and darker than most, formed by fall spawners. Markirg of known redds during spring and fall surveys is planned.

Trout spawning in the Jocko River was concentrated between Valley Creek (km 19) and Finley Creek (km 31). Below Valley Creek, flows and depth of the Jocko River increase. Upstream from Finley Creek, substrate size increases markedly. Collection of ripe mountain whitefish in the Jocko River suggests whitefish spawn in this tributary.

Spawning may begin in the Little Bitterroot River as early as February and continue until late May. Traps set in the Little Bitterroot River during early February and operated into June should confirm pike spawning time, peaks in activity, and turnaround times. The distances northern pike migrate to spawn in this stream are not known. Their movement probably is hampered by flow reduction from irrigation withdrawals and by growth of aquatic vegetation.

Several fishermen reported having discarded tags before being aware of this study; probably more tagged northern pike were captured in the Little Bitterroot River than tag returns indicate. Efforts will continue to increase fishermen awareness of the program and the importance of returning tags.

Temperature profiles for Crow Creek, the Little Bitterroot River, and Camas Creek suggest they represent sub-optimum habitat for cold-water aquatic life during July and August. Summer water temperatures in these tributaries consistently exceed MDHES (1982) standards.

CONCLUSIONS

Preiiminary observations indicate water level fluctuations in the main river due to daily hydroelectric operations at Kerr Dam may have a significant negative impact upon reproductive success of nothern pike, trout, and whitefish by dewatering spawning areas during and after egg deposition, and by stranding larval fish. Evaluation of fish stocks and specific spawning sites over the next four years will be used in formulating management strategies to mitigate these impacts.

Sedimentation in the main river increases below the confluence with the Little Bitterroot River. Potential spawning gravels for salmonids have been severely degraded by sedimentation in several areas of the main river and tributaries. Sediment origin and possible correction actions will be assessed. Sedimentation and fluctuation of water level may have a significant impact upon aquatic insect production in the main river, and further study along these lines should be initiated.

All target fish species have been found throughout the lower river with the exception of the first six kilometers below Kerr which have not been sampled. The most common game fish are mountain whitefish and northern pike, respectively. Movement of trout and pike between tributaries and the main river has been documented. The extent and timing of movement will be evaluated using semi-permanent weirs on the Jocko River and Mission Creek. Upstream and downstream traps will be used on the Little Bitterroot River to monitor northern pike movement between the main river and this tributary.

Flow requirements for different life stages of target fish species need to be evaluated to determine their impact upon possible fisheries management strategies and hydroelectric power production. Instream Flow Incremental Methodology will be used to determine optimum spawning flows for each species and the flows needed for each life stage. Measurements will be made at specific flows during fiscal year 1985. Management options based on physical parameters and stock assessments will be developed in fiscal year 1987. Management options will be developed in fiscal year 1987.

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APPENDIX A

Fish species found in the lower Flathead River System

Fish species found in the lower Flathead River System.

Common Name	Scientific Name
Rainbow trout	*Salmo gairdneri*
Cutthroat trout	*Salmo clarki*
Brown trout	*Salmo trutta*
Bull trout	*Salvelinus confluentus*
Brook trout*	*Salvelinus fontinalis*
Mountain whitefish	*Prosopium williamsoni*
Lake whitefish	*Coregonus clupeaformis*
Northern pike	*Esox lucius*
Largemouth bass	*Micropterus salmoides*
Black bull head	*Ictaluras melas*
Yellow bullhead	*Ictaluras natalis*
Yellow perch	*Perca flavescens*
Pumkinseed	*Lepomis gibbosus*
Northern squawfish	*Ptychocheilus oregonensis*
Peamouth chub	*Mylocheilus caurinus*
Redside shiner	*Richardsonius balteatus*
Longnose dace*	*Rhinichthys cataractae*
Largescale sucker	*Catostomus macrocheilus*
Longnose sucker	*Catostomus catostomus*
Slimy sculpin	*Cottus cognatus*

*not yet collected in main river

APPENDIX B

Sample forms for stream habitat survey (Fraley unpublished) and Stream Reach Inventory and Channel Stability Evaluation (USFS 1978).

STREAM: DATE: TIME: AIR: WATER: CREW:

Transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Wetted Width (m)																														
Feature: Pool =P Riffle=R Run =RN Pocket=PW																														
Additional Features																														
Compaction (N,L,M,H)																														
D50 (c m)																														
Embeddedness (%) (<25, 25-50, 50-75, >75)																														
Channel Cover (%): Ch																														
Can																														
Instr																														
Debris: Channel / Flood Plain																														
Channel Width (m)																														
Aquatic Veg: Type (S,E) / N, L, M, H																														
Average Depth (c m)																														
Flood Signs: HT (m) / Type(D,E,P,M,H)																														
Bank Material (fines, gravel, cobble, boulder, bedrock)																														
Bed Material (f,g,c,b,b)																														

Side Channel (m)
Vert. Stability
Turbidity
Stage
Stable Debris (%)
Bank Form

Pools
III
II
I

Valley Flat
Maximum Depth (c m)
Stream Pattern
Flow Character
Flood Signs (Type, Ht)

CHANNEL STABILITY EVALUATION

Item Rated	Stability Indicator Classes							
	A		B		C		D	
UPPER BANKS								
Landform Slope	Bank slope gradient <30%.	(2)	Bank slope gradient 30-40%.	(4)	Bank slope gradient 40-60%.	(6)	Bank slope gradient 60%+.	(8)
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	(12)
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	(8)
Bank Protection from Vegetation	90%+ plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	(12)
LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio < 7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Ocassional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio > 25.	(4)
Bank Rock Content	65%+ with large, angular boulders 12"+ numerous.	(2)	40-65%, mostly small boulders to cobbles 6-12".	(4)	20-40%, with most in the 3-6" diameter class.	(6)	< 20% rock fragments of gravel sizes, 1-3" or less.	(8)
Obstructions Flow Deflectors	Rocks, old logs firmly embedded. Flow pattern of pools & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong.	(8)
Cutting	Little or none evident. Infrequent raw banks.	(4)	Some intermittently at outcurves and constrictions.	(8)	Significant. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts. Failure of overhangs frequent.	(16)
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increase in bar formation, mostly from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominantly fine particles. Accelerated bar development.	(16)
BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners and edges, surfaces smooth and flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	(4)
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull, but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15% i.e., 35-65%.	(3)	Predominantly bright, 65%+, exposed or scoured surfaces.	(4)
Consolidation or Particle Packing	Assorted sized tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	(8)
Bottom Size Distribution & Precent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change is sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials < 20%.	(16)
Deposition	< 5% of the bottom affected by deposition.	(6)	5-30% affected. Some deposition in pools.	(12)	30-50% affected. Deposits at obstructions, constrictions, and bends. Some filling of pools.	(18)	> 50% of the bottom in a state of flux or change nearly yearlong.	(24)
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4)
	COLUMN TOTALS →		→		→		→	

Size Composition of Bottom Materials (Total to 100%)

1. Exposed bedrock..........____%
2. Large boulders, 3'+ Dia....____%
3. Small boulders, 1-3'.......____%
4. Large rubble, 6-12".......____%
5. Small rubble, 3-6"......____%
6. Coarse gravel, 1-3".....____%
7. Fine gravel, 0.1-1".....____%
8. Sand, silt, clay, muck..____%

TOTAL SCORE ________

1/ Modified from U. S. Department of Agriculture Forest Service/Northern Region.

APPENDIX C

Locations of reach boundaries, habitat survey sections, and stock assessment stations on five major tributaries to the lower Flathead River.

JOCKO RIVER

Beach 1	Stream km	
Boundaries: mouth to Spring Canyon	0.0 to 5.8	
Habitat survey: Dixon Bridge upstream	1.6 to 3.2	
Fish sampling station (150		3.2
Comments: reach open and braided below Bison Range canyon		

Beach 2	
Boundaries:Spring Canyon to Hwy 200	5.8 to 13.8
Habitat survey: Section 25/26 boundary upstream	8.8 to 10.4
Fish sampling station (150 m): Sec 25/26 boundary	10.4
Comments : reach confined along Bison Range	

Reach	
Boundaries: Hwy 200 to Valley Creek	13.8 to 19.0
Habitat survey: North Valley Creek Road downstream	16.9 to 16.5
Fish sampling station (150 m):North Valley Creek road	18.5
Comments`: reach still somewhat confined; Valley Creek influence	

Beach 4	
Boundaries: Valley Creek to Finley Creek	19.0 to 30.7
Habitat survey: South Valley Creek Road downstream	23.2 to 24.8
Fish sampling station (150 m): South Valley Creek road	23.2
Comments : reach unconfined; Finley Creek influence	

Reach 5	Stream km
Boundaries: Finely Creek to K canal	30.7 to 41.8
Habitat survey: Teresa Adams Road downstream	36.7 to 38.3
Fish sampling station (150 m): behind Clinkenbeard ranch, sec 7	36.8

Comments : reach has hatchery influence and dewatered section

Reach 6	
Boundaries: K Canal to North Fork Jocko River confluence	41.8 to 48.9
Habitat survey:Section 31/36 road crossing upstream	45.2 to 46.8
Fish sampling station (150 m): Sec 31/36 road crossing	45.2

Comments: reach with Pistol Creek and North Fork Jocko River

Reach 7	
Boundaries: North Fork to Middle Fork Jocko River	48.9 to 55.3
Habitat survey:Section 27/28 road upstream	52.1 to 53.7
Fish sampling station (150 m): Section 27/28 road	52.1

Comments: South and Middle Fork converge at reach head

MISSION CREEK

Beach 1	
Boundaries: mouth to Burlington Northern RR bridge	0.0 to 5.5
Habitat survey:0.5 km below old bridge upstream	1.6 to 3.2
Fish sampling station (150 m): 0.5 km above old bridge	2.6

Comments : reach has clay banks at lower end; steeper above BN RR

Peach 2	Stream km
Boundaries:BN RR bridge to Post Creek	5.5 to 13.4
Habitat survey:H Canal diversion downstream	9.7 to 11.3
Fish sampling station (150 m): 0.5 km below H Canal diversion	10.8
Comments: reach has Post Creek influence	

Reach 3	
Boundaries: Post Creek to Hwy 93 bridge	13.4 to 21.7
Habitat survey: Section 9/10 road upstream	17.4 to 19.2
Fish sampling station (150 m): 32 above section 9/10 road	17.4
Comments: gradient steepens above St. Ignatius	

Reach 4	
Boundaries: Hwy 93 to Mission B Canal	21.7 to 25.1
Habitat survey: high school road upstream	22.9 to 24.5
Fish sampling station (150 m): Section 13.24 road	24.0
Comments: Mission "B" Canal influence	

Peach 5	
Boundaries: Mission B Canal to Mission Reservoir outlet	25.1 to 26.9
Habitat survey: Section 19/20 road upstream	25.3 to 26.9
Fish sampling station (150 m): Section 19/20 road	25.3
Comments: steepest reach	

POST CREEK

Reach 1	Stream km
Boundaries: mouth to narrowed area	0.0 to 2.3
Habitat survey: Section 33 road downstream	0.2 to 1.8
Fish sampling station (150 m): Section 33 road	1.8
Comments: reach broad and flat	

Reach 2	
Boundaries: narrowed area to McDonald Lake Road Section 13/24	2.3 to 11.1
Habitat survey: Section 22/27 road upstream	6.0 to 7.6
Fish sampling station (150 m): Section 23 road	6.8
Comments: reach sinuous with low gradient	

Reach 3	
Boundaries: McDonald Lake Road Section 13/24	11.1 to 16.9
Habitat survey: Section 5/6 road upstream	13.7 to 15.3
Fish sampling station (150 m): Section 5/6 road	13.7
Comments: straighter, steeper reach; canal at head	

Reach 4	
Boundaries: Pablo Feeder Canal to McDonald Lake outlet	16.9 to 20.0
Habitat survey: footbridge above Pablo Feeder Canal upstream	16.9 to 18.5
Fish sampling station (150 m): footbridge above Pablo Feeder Canal	16.9
Comments: short, steep reach	

CROW CREEK

Peach 1	Stream km
Boundaries: mouth to Lower Crou Reservoir outlet	0.0 to 5.6
Habitat survey: Footbridge Hoiese Canal downstream	3.2 to 4.8
Fish sampling station (150 m): Moiese Canal diversion	4.8

Comments: reach has uniform gradient; reservoir is barrier

LITTLE BITTERROOT RIVER

Reach 1	
Boundaries: mouth through canyon	0.0 to 5.6
Habitat survey: mid-canyon near road in Section 24 upstream	1.6 to 3.2
Fish sampling station (150 m): near road in Section 24	2.1

Comments : reach has steeper canyon area with rocky bottom

Peach 2	
Boundaries: canyon to Hot Spring Creek	5.6 to 44.1
Habitat survey: hydrologic gaging site downstream	16.3 to 17.9
Fish sampling station (150 m): hydrologic gaging site	16.3

Comments : Hot Springs Creek introduces heavy sediment load

Reach 3	
Boundaries: Hot Springs Creek to Sullivan Creek	44.1 to 55.7
Habitat survey: Section 29/20 road upstream	45.9 to 47.5
Fish sampling station (150 m): Section 29/20 road	45.9

Comments: Sullivan Creek is another sediment source

Beach	Stream km
Boundaries: Sullivan Creek to Camas "A" Canal	55.7 to 76.0
Habitat survey: Section 22 crossroads upstream	61.3 to 62.9
Fish sampling station (150 m): Section 22 crossroads	61.3

Reach 5

Boundaries: Camas "A" Canal to Reservation boundary	76.0 to 82.1
Habitat survey: canyon area Section 9 upstream	77.2 to 78.8
Fish sampling station (150 m): canyon area Section 9	77.2

APPENDIX D

Summary of location, capture date, number captured, and size range for target species collected from the tributaries during Phase I of the lower Flathead River Fisheries Study.

JOCKO RIVER

Location (stream km)	Date	Species	No.	Size Range (mm)
Electrofishing				
.4	03-01-83	RB	5	84-263
"	03-01-83	LL	5	128-212
"	04-07-83	RB	1	359
"	04-07-83	MWF	14	223-326
"	04-07-83	LL	1	114
56.3	07-25-83	CT	45	75-282
"	07-25-83	EB	52	52-204
1.6	08-17-83	RB	4	189-384
"	08-17-83	LL	2	99-375
"	08-17-83	DV	1	314

MISSION CREEK

Location (stream km)	Date	Species	No.	Size Range (mm)
Electrofishing				
6.4	03-11-83	MWF	8	295-380
"	03-11-83	RB	2	275-384
24.0	08-31-83	RB	30	77-276
"	08-31-83	EB	74	61-270
"	08-31-83	MWF	10	102-203
"	09-07-31	RB	22	65-282
"	09-07-83	EB	62	67-226
"	09-07-83	MWF	2	109-122

CROW CREEK

Location (stream km)	Date	Species	No.	Size Range (mm)
Electrofishing				
.8	03-11-83	MWF	7	263-460
"	03-11-83	RB	1	147
4.0	08-30-83	RB	10	83-118
"	08-30-83	MWF	17	130-154
"	09-06-83	RB	10	74-126
"	09-06-83	MWF	37	131-320

LITTLE BITTERROOT RIVER

Location (stream km)	Date	Species	No.	Size Range (mm)
Upstream Trapping				
59.5	03-25-83	NP	3	423-484
"	03-27-83	"	2	460-522
"	03-28-83	"	2	448-513

LITTLE BITTERROOT RIVER

Location (stream km)	Date	Species	No.	Size Range (mm)
Upstream Trapping				
59.5	03-29-83	NP	1	530
"	03-30-83	"	1	507
"	03-31-83	"	1	526
"	04-01-83	"	1	521
"	04-05-83	"	2	487-504
"	04-07-83	"	2	404-485
"	04-09-83	"	2	475-622
"	04-16-83	"	1	410
"	04-19-83	"	1	501
"	04-20-83	"	2	347-422
"	04-22-83	"	2	414-512
4.8	04-22-83	"	1	349
"	04-25-83	"	1	345
Downstream Trapping				
59.9	04-21-83	NP	16	424-622
"	04-22-83	"	4	364-528
"	04-25-83	"	6	392-542
"	04-29-83	"	2	512-540
"	05-02-83	"	8	404-519
"	05-04-83	"	12	402-529
"	05-06-83	"	2	460-457
"	05-16-83	"	7	396-534
"	05-19-83	"	10	392-525
"	05-23-83	"	7	382-509
"	05-25-83	"	8	269-478
"	05-27-83	"	5	266-453
"	05-31-83	"	1	279
"	06-02-83	"	1	425
"	06-06-83	"	1	425
"	06-09-83	"	1	381
4.8	06-06-83	"	1	377
"	06-27-83	"	2	342-418
Electrofishing				
61.14	03-04-83	NP	6	175-233
"	03-09-83	"	5	140-208
59.5	04-05-83	"	9	173-494
61.5	04-14-83	"	5	213-442
59.5	04-20-83	"	8	397-499
44.3	05-20-83	"	10	452-582
57.1	05-23-83	"	2	373-384
44.3	05-24-83	"	32	179-625
"	05-25-83	"	12	189-606
45.9	06-08-83	"	6	364-573
59.5	07-27-83	"	1	306

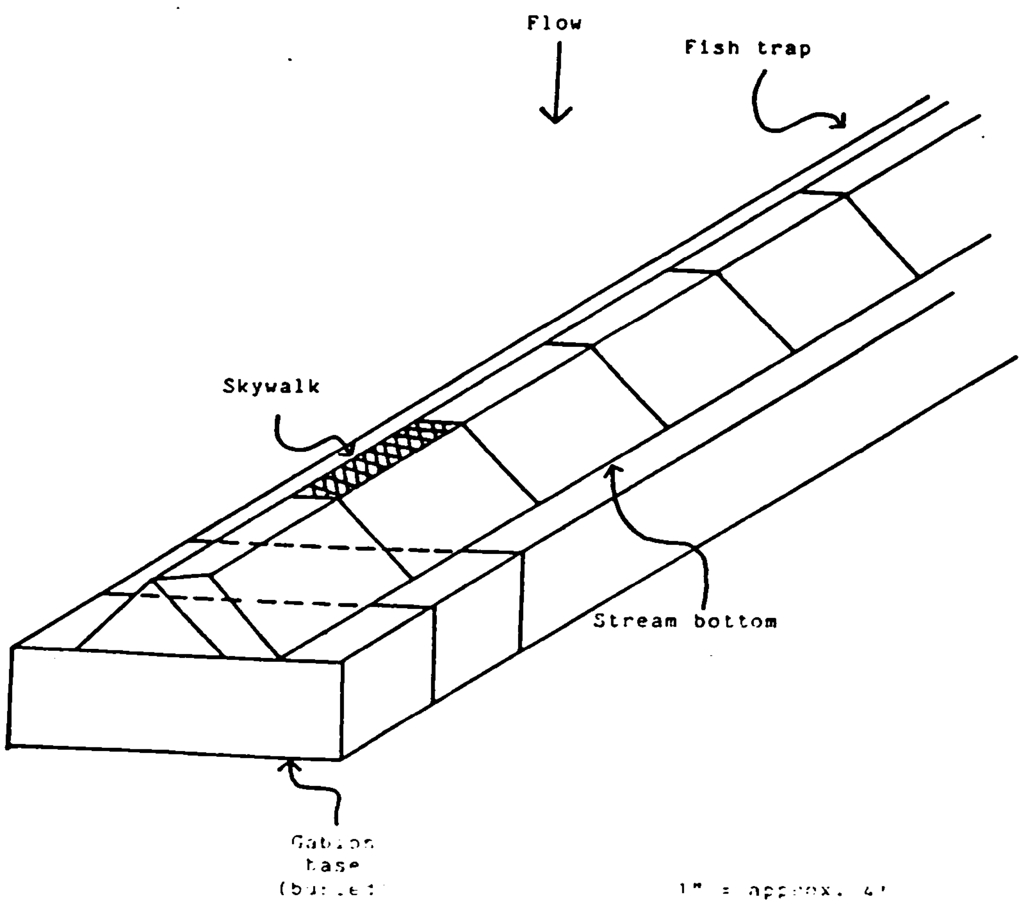
APPENDIX E

Proposed weir design for the Jocko River and Mission Creek.

MODULAR FISH WEIR

GENERAL DESCRIPTION OF WEIR

The modular fish weir consists of a series of four-foot long angle iron modules bolted together and wired to a gabion base extending across the stream. Each module is trapezoidal in shape, 24 inches high and with base and top widths of 66 inches and 18 inches, respectively (widths are side-view, upstream to downstream dimensions). Upstream faces of modules are constructed to receive metal rod panels utilized when trapping spawning runs and screened panels which are utilized with the metal rod panels when trapping downstream migrants. Metal skywalk is placed on top of weir modules for a walkway. Fish traps are designed to fit into any selected module opening when panels are removed. The weir is installed at an angle across the stream with the spawner trap located at the upstream end.



MODULAR FISH WEIR

MODULAR CONSTRUCTION

Form 1½" X 152" angle iron into trapezoidal shape for end sections by cutting one leg of angle iron at appropriate points and bending remaining leg. Weld the two ends where they meet. Two end sections per module are required. Weld 1½" X 31" angle iron brace in each end section. Weld upper end 3" from the top of end section.

Weld 1½" X 3/4" X 34" channel iron to top of vertical leg of angle iron on end section in position labeled 1 on plan sheet. Open sides of channel will face in when module is assembled. Channels will be glides and holders for metal rod panels. Weld in stop at bottom of channels to hold panels in place.

Number 3 on plan sheet is an enlarged end view of center glide and holder for metal rod panels (#2 on plan sheet). Weld two 1½" X 34" angle irons to form inverted T. Weld two 1½" X 3/4" X 34" channels back to back and to vertical leg of inverted T. Weld in stops in bottom of channels. When assembled, the two channels of assembly #3 will have their open sides facing the open sides of the channels located in position #1, thereby providing grooves to accommodate two panels per module.

Weld three of the twelve 1½" X 3/4" X 2" channels on top of each of the four 34" channels in position #1 and #3. Weld them at the top, middle and bottom of each 34" channel with stops welded in the bottom pieces. As with the 34" channels, these 2" pieces will have their open sides facing each other. They will serve as holders and glides for the screened panels. See #4 on plan sheet.

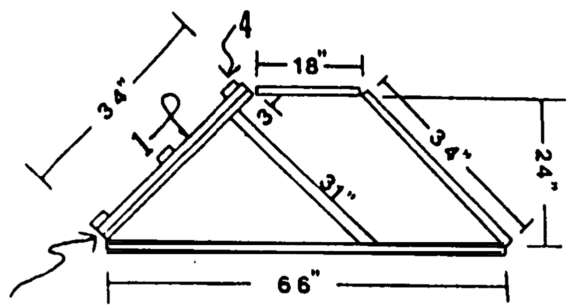
Drill or punch ½" holes before forming each section for use in module assembly.

Two metal rod panels are required per module (#2 on plan sheet). These panels slide into openings labeled 2 on plan sheet and on upstream side of weir. Weld frame for panels using two 1" X 23½" angle irons for top and bottom sections and two 1" X 34" angle irons for sides. Miter corners. Weld 15½" X 34" metal rods on 1½" centers. No opening should be greater than 1" to prevent gilling of fish. Weld frames for screened panel in the same manner, but without metal rods. Bolt 23½" X 34" screen sections to frames using metal strips to hold screening in place.

Assemble modules with 1½" X 48" angle irons. Beginning at bottom of upstream face marked 1 on plan sheet, bolt 48" angle irons with one 7/16" X 1½" bolt in each end. Place one 48" angle iron at bottom of upstream face, one at top of face, one on each side of top of end section and one at bottom of downstream face.

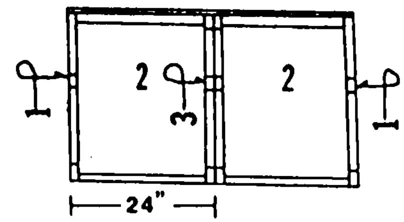
Bolt assembly 3 to center of top and bottom 48" angle iron using two 7/16" X 1½" bolts in each end. Bolt 18" angle iron in center of two side 48" angle irons on top of end sections. Place on bottom of 48" angle irons except the 18" piece will be up.

MODULAR FISH WEIR PLAN SHEET

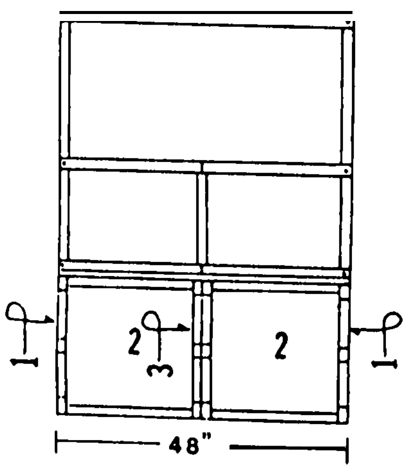


Welds op at
bottom of channels

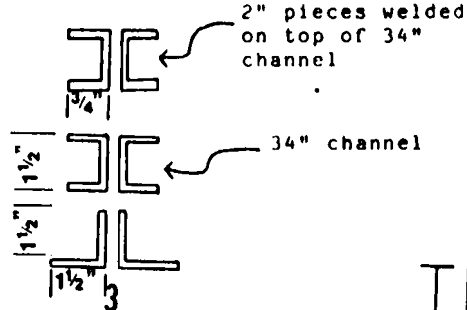
END ELEVATION



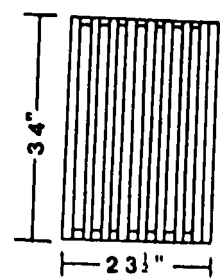
SIDE ELEVATION



TOP VIEW



Exploded View



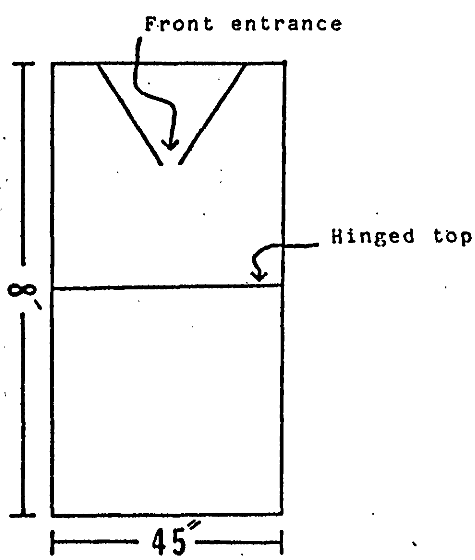
2

SPAWNER TRAP UTILIZED WITH THE MODULAR FISH WEIR

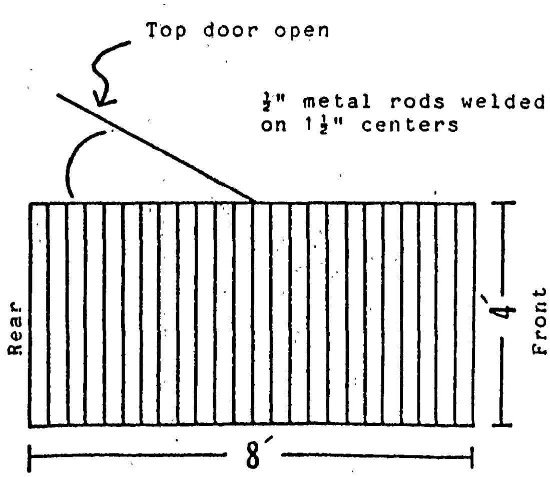
One spawner trap required for weir.

Assemble trap by welding ½" metal rods to 1" angle iron frame on front, rear and side faces. Width of trap will be about 45" so that it will slide into any selected weir module opening with assembly #3 removed. Trap length and height will be 8' and 4', respectively. Construct top and bottom of trap with 1/8" thick perforated aluminum plate.

Construct front side of trap with two adjustable sections which can be angled inward toward each other to form fish entrance openings of various widths. The top consists of two 45" X 48" sections. The front section (section over the angled entrance) is bolted to the 1" angle iron and the rear section is connected to the front section with hinges to form an entrance to the trap. The rear edge of the rear top section will be latched and locked to the top of the rear side of the trap when left unattended. All sides will be bolted to each other and to the bottom section and front half of the top section.

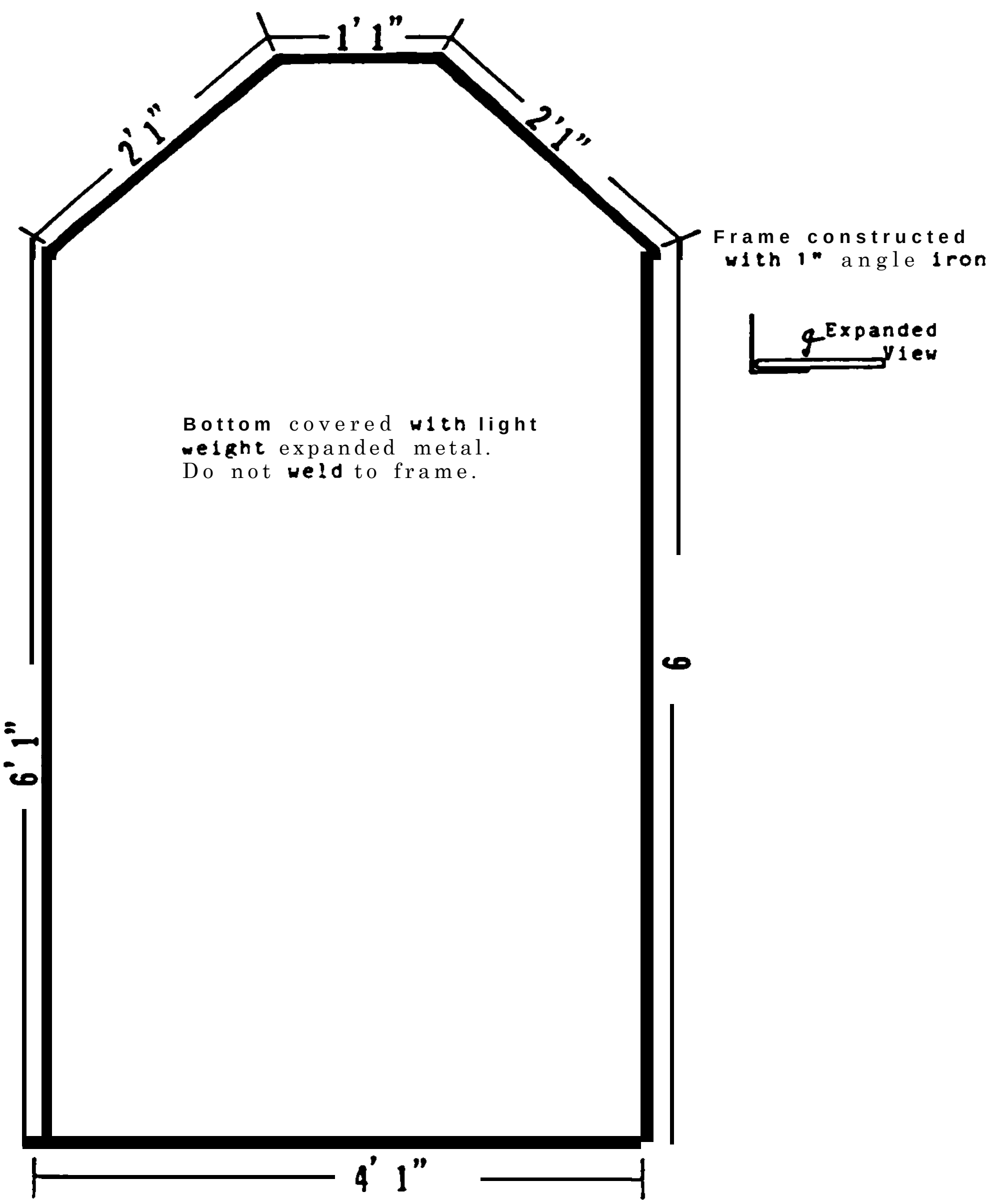


TOP VIEW



SIDE VIEW

MANZANITA FISH TRAP
(Bottom of Trap)



MODULAR FISH WEIR

WEIR INSTALLATION

Install gabion base in stream bed with long axis of gabions parallel to current. Gabions are placed in a trench extending across stream and situated so that their top faces are flush with the stream bottom when installation is completed

Weir modules are anchored to the gabion base by wiring the modules to 1/2"" rebar embedded in the gabions. Front edges of modules should be well tied to prevent weir from rotating under water pressure. Modules are bolted end to end with a mininum of 3 7/16" X 1 1/2" bolts with lock washers, all plated to prevent rust. Place one bolt each on front, back. and top. Place panels in place on upstream face of weir and place skywalk on top of weir for walkway.

DOWNSTREAM MIGRANT TRAP UTILIZED WITH THE MODULAR FISH WEIR

Two downstream migrant traps required for weir.

Assemble entire trap with 1/8" perforated aluminum plate welded together. Trap width and height will be about 21" and 24", respectively, so that traps will slide and snugly fit any selected weir module opening with assembly #3 in place. Trap will be 6' long.

Construct front end of trap with two sections angled inward toward each other to form a fish entrance opening of one inch. Entrance opening does not have to be adjustable as with spawner trap. The top consists of a 4' long front section which is welded to the sides and front end and a 2 long rear section which 1s connected to adjacent section with hinges to form a lid. The rear edge of the lid will be assembled so that it can be fastened down and locked.

APPENDIX F

Summary of fisheries and temperature data collected on the main river.

ELECTROFISHING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Foust SL.	02-03-83	YP	5	121-249
"	"	LMB	2	216,342
"	"	BB	3	168-222
"	"	MWF	1	478
Agency SL.	03-10-83	LMB	1	332
"	"	NP	4	328-623
M. of Jocko	03-10-83	MWF	9	266-364
Foust SL.	03-16-83	LMB	8	157-211
"	"	PM	1	310
"	"	NP	3	298-696
McDonald SL.	03-22-83	LMB	19	306-527
N.W. Sink Hole	02-28-83	LMB	24	262-470
"	"	NP	1	839
Agency SL.	03-29-83	LMB	2	332,335
"	"	NP	11	277-655
Perma to Robinson CR.	04-14-83	LL	5	253-531
M. of Little Bitterroot to Sloan's Bridge	05-04-83	MWF	3	242-307
"	"	NP	1	724
Buff. Br. Downstream	05-13-83	MWF	41	244-424
McDonald SL.	05-18-83	LMB	14	318-462
"	"	NP	5	594-665
"	05-19-83	NP	6	399-850
"	"	LMB	4	277-352
N.W. Sink Hole	05-24-83	LMB	12	228-518
Buff. Br.	05-26-83	MWF	34	172-331
"	"	LL	1	451
N.W. Sink Hole	06-10-83	LMB	12	217-420
"	"	NP	2	436,491
Perma #1	06-15-83	MWF	65	169-392
"	"	LL	4	403-567
"	"	RB	1	409
"	"	LMB	1	356
Perma #2	06-16-83	MWF	13	293-428
"	"	LWF	8	295-492
"	"	LMB	2	237-279
"	"	NP	1	496
Perma #1	06-21-83	MWF	39	170-392
"	"	LL	3	603-624
"	"	RB	1	223
McDonald SL.	07-15-83	LMB	5	295-505
Perma Downstream	07-19-83	RB	3	315-360
"	"	LL	1	452
"	"	MWF	2	185,190
Buff. Br.	07-20-83	MWF	8	219-356

ELECTROFISHING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Buff. #1	09-25-83	MWF	202	115-368
"	"	LL	2	274,311
Buff. #2	09-26-83	MWF	280	120-480
"	"	LL	3	284-490
"	"	NP	4	610-770
Weeds #1	09-27-83	MWF	125	115-402
"	"	RB	11	201-350
"	"	CT	1	243
"	"	NP	27	298-1,000
Weeds #2	09-28-83	MWF	185	100-427
"	"	RB	3	212-244
"	"	CT	1	277
"	"	NP	5	326-600
"	"	LL	4	210-517
"	"	DV	1	306
Buff. #1	10-02-83	MWF	219	211-378
"	"	LL	4	266-392
"	"	RB	1	266
Buff. #2	10-03-83	MWF	282	140-372
"	"	LL	7	257-356
"	"	RB	1	401
"	"	CT	1	377
"	"	NP	6	750-922
Weeds #1	10-04-83	MWF	195	116-465
"	"	RB	4	228-353
"	"	CT	3	214-274
"	"	NP	21	272-760
Weeds #2	10-05-83	MWF	111	125-388
"	"	LL	5	211-248
"	"	RB	8	170-271
"	"	CT	1	304
"	"	NP	9	364-672
Sloan #1	10-16-83	MWF	186	212-446
"	"	LL	2	282,450
"	"	RB	1	250
"	"	NP	1	781
Sloans #2	10-17-83	MWF	86	200-420
"	"	NP	3	334-350
"	"	RB	1	235
Dixon #1	10-18-83	MWF	129	198-450
"	"	NP	7	390-1,040
"	"	RB	5	230-247
Dixon #2	10-19-83	MWF	314	196-440
"	"	NP	5	296-398
"	"	RB	3	226-254

ELECTROFISHING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Dixon #2	10-19-83	LL	2	254,375
Sloan #1	10-23-83	MWF	452	216-461
"	"	NP	1	816
"	"	LL	2	276,375
Sloan #2	10-24-83	MWF	283	218-434
"	"	NP	3	330-549
"	"	LL	2	258-326
"	"	CT	1	289
"	"	RB	1	246
Dixon #1	10-25-83	MWF	145	218-460
"	"	NP	11	333-795
"	"	RB	3	246-283
"	"	LL	2	275-470
"	"	CT	1	305
Dixon #1	10-30-83	MWF	394	?
"	"	NP	13	312-980
"	"	RB	4	233-296
"	"	LL	3	276-567
"	"	DV	1	274
Dixon #2	10-31-83	MWF	584	?
"	"	NP	5	285-640
"	"	LL	4	231-493
"	"	RB	10	217-314
"	"	CT	1	245

TRAPPING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm
McDonald SL. #1	03-22-83	NP	1	316
"	03-23-83	NP	2	370,390
"	03-28-83	NP	1	403
McDonald SL. #2	03-28-83	NP	1	311
"	"	LMB	2	217,251
Sink Hole	04-05-83	CSU	4	?
"	"	PM	7	?
"	04-06-83	PM	2	260,363
"	"	LNSU	2	486,492
"	"	CSU	2	352,460
"	"	SQ	1	328
"	04-07-83	NP	1	636
"	"	CSU	2	510,514
"	"	LNSU	1	420
"	"	PM	3	255-333
"	04-12-83	CSU	1	?
Sink Hole Culvert	04-13-83	CSU	1	?
Duck Pond	04-15-83	LNSU	2	464,523
"	"	CSU	3	366-533
Sink Hole Culvert	"	CSU	1	275
Ferry SL. #1	04-20-83	NP	7	351-925
"	04-21-83	NP	3	660-785
"	04-22-83	NP	1	653
Ferry SL. #2	05-03-83	NP	4	622-714
"	05-04-83	NP	2	680,687
"	05-05-83	NP	1	646
"	"	LMB	1	411
Duck Pond	05-17-83	NP	1	820
Ferry SL. #2	05-21-83	LMB	1	339

GILL NETTING SUMMARY

Location	Date	Species	No. Captured	Range in Size (mm)
Sink Hole	03-24-83	NP	1	964
"	03-25-83	NP	3	380-438
Mouth of Little Bitterroot	04-01-83	PM	28	240-361
"	"	LSSU	3	415-446
Sink Hole	04-07-83	NP	6	377-653
Pike Hole	"	NP	3	380-853
South Sink Hole	04-13-83	NP	6	596-709
"	"	LL	1	513
"	"	LMB	2	357,387
"	"	YP	29	?
"	"	SQ	5	?
"	"	CSU	1	?
McDonald SL.	04-20-83	CSU	3	411-484
"	"	NP	9	387-763
"	"	SQ	1	360
Sink Hole	"	NP	6	365-680
"	"	LMB	1	264
Foust SL.	04-21-83	NP	13	285-636
McDonald SL.	04-28-83	NP	6	380-877
"	"	LMB	1	286
"	04-29-83	NP	5	407-694
"	"	LMB	1	345
Sink Hole	05-17-83	NP	7	371-490

SEINE HAULS - 50' MINNOW SEINE

Location	Date	Species	No. Captured	Range in Size (mm)
Cattail Marsh	05-16-83	MWF	31	Fry
Duck Pond	"	YP	1	
"	"	MWF	34	
"	"	RSS	9	
"	"	PUM	29	
"	"	SQ	11	
"	"	CSU	14	
Culvert	"	SQ	11	
"	"	MWF	3	
"	"	RSS	2	
"	"	YP	1	
"	"	CSU	2	
Foust SL.	08-01-83	YP	35	Fry
"	"	SQ	36	"
"	"	PUM	16	"
"	"	RSS	2	"
"	"	YP	2	104-192
"	"	LMB	2	125-136
Sink Hole	08-02-83	LMB	10	91-348
"	"	NP	1	518
Horse Shoe Bend SL.	08-03-83	YP	12	
"	"	RSS	2	
100 yds. Below Mouth of LBR	"	NP	2	186-200
"	"	YP	2	
"	"	RSS	3	
"	08-04-83	NP	5	216-481
Pike Hole	08-18-83	NP	4	168-175
"	"	YP	1	130
"	"	LMB	1	128

TEMPERATURE DATA 1983

		Kerr[1]	Sloan	Dixon	Perma
Jan.	max	3.1			
	mean	2.0			
	min	0.8			
Feb.	max	4.5			
	mean	3.0			
	min	1.5			
Mar.	max	5.7	6.6*	7.5*	6.2*
	mean	4.5	5.6	5.6	4.9
	min	3.6	4.1	3.6	3.3
Apr.	max	11.2	12.0	13.0	12.2
	mean	7.5	7.8	9.7	7.4
	min	4.8	5.0	4.9	4.5
May	max	15.6	10.8*	15.8	15.9
	mean	10.5	9.7	11.0	10.4
	min	8.1	8.2	7.8	7.4
Jun.	max	17.9		15.0*	
	mean	16.0		14.5	
	min	14.4		13.8	
Jul.	max	19.4	21.4*	19.5*	21.3*
	mean	16.5	18.8	17.7	17.2
	min	14.9	17.0	15.2	14.8
Aug.	max	22.7*	24.5	22.5	26.3
	mean	21.5	21.9	19.3	21.2
	min	19.4	19.9	16.1	17.1
Sep.	max	21.2	22.0	20.0	21.5
	mean	16.0	16.2	14.4	15.5
	min	12.7	12.7	10.1	10.8

1 - Temperature data provided by the USGS and recorded directly below Kerr Dam.

* - indicates incomplete daily recordings for that month and station.

SUMMARY OF EXPENDITURES FY 1983

Personnel	104,297.58
Non-Expendable	58,404.26
Expendable	5,256.27
Travel & Transportation	12,658.43
Contracted Services	1,378.30
Operation & Maintenance	14,577.85
Administrative Support	10,358.50
Indirect Cost	13,070.37
	220,001.56

MAJOR EQUIPMENT PURCHASED FY 83

BPA #	ITEM
154616	Adler SE1010 Typewriter
154617	Marsh-McBirney Model 201 Flowmeter
154618	Carver Lab Press-Model C
154619	Mercury 80 hp Outboard Motor
154620	VVP-2C Electrofisher
154621	Homelite E-1350-1 Generator
154623	BP-1C Backpack Shocker
154624	" " " "
154625	Coffelt Boat System
154626	Shoreline Boat - Trailer R17-20
154627	Nikonos IV-A Camera
154628	Lufkin 100' Tape Measure

SUMMARY OF EXPENDITURES CONT.

BPA #	ITEM
154629	Sharp Model CS-1191 Calculator
154630	Northwest Microfilm Microfiche Reader NMI-90
154632	Homelite 5000-watt Generator (on boat)
154706 thru 154713	8 Ryan Peabody 90-day Thermographs
154714	Eska 15 hp Outboard Motor
154715	Lowe 12-ft Lakejon
154716	E-Z Loader Boat Trailer
154717	VVP-15 Electroshocker
154718	Lufkin 100' Tape Measure